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Abstract

We present two post-stratification weighting methods to validate survey data collected using Amazon Mechanical Turk (AMT). Two surveys focused on appliance and consumer electronics devices were administered in the spring and summer of 2012 to each of approximately 3,000 U.S. households. Specifically, the surveys asked questions about residential refrigeration products, televisions (TVs) and set-top boxes (STBs). Filtered data were assigned weights using each of two weighting methods, termed "sequential" and "simultaneous," by examining up to eight demographic variables (income, education, gender, race, Hispanic origin, number of occupants, ages of occupants, and geographic region) in comparison to reference U.S. demographic data from the 2009 Residential Energy Consumption Survey (RECS). Five key questions from the surveys (number of refrigerators, number of freezers, number of TVs, number of STBs and primary service provider) were evaluated with a set of statistical tests to determine whether either method improved the agreement of AMT with reference data, and if so, which method was better. The statistical tests used were: differences in proportions, distributions of proportions (using Pearson's chi-squared test), and differences in average numbers of devices as functions of all demographic variables. The results indicated that both methods generally improved the agreement between AMT and reference data, sometimes greatly, but that the simultaneous method was usually superior to the sequential method. Some differences in sample populations were found between the AMT and reference data. Differences in the proportion of STBs reflected large changes in the STB market since the time our reference data was acquired in 2009. Differences in the proportions of some primary service providers suggested real sample bias, with the possible explanation that AMT user are more likely to subscribe to providers who also provide home internet service. Differences in other variables, while statistically significant in some cases, were nonetheless considered to be minor. Depending on the intended purpose of the data collected using AMT, these biases may or may not be important; to correct them, additional questions and/or further post-survey adjustments could be employed. In general, based on the analysis methods and the sample datasets used in this study, AMT surveys appeared to provide useful data on appliance and consumer electronics devices.

Table of Contents

1 Introduction

The Energy Information Administration (EIA) within the U.S. Department of Energy (DOE) reports that the share of energy used by appliance and consumer electronics devices has increased in U.S. households from 17% in 1978 to 31% in 2005 (EIA, 2011). This number is expected to increase in the future with growing demand for more and better household appliances and consumer electronics, despite significant improvements in energy efficiency.

There are several existing sources of household device information, including public data from the Residential Energy Consumption Survey (RECS) administered by EIA, the Association of Home Appliance Manufacturers (AHAM), and Appliance Magazine. Other data are available from private market research firms such as NPD Group, The Nielsen Company, IMS Research, and DisplaySearch. These data can be used to estimate device sales, numbers and types of devices per household, national energy use and potential savings, and perform a detailed cost-benefit analysis of improved efficiency, for most major household device types (heating, cooling and ventilation equipment; "white goods" such as refrigerators, water heaters, clothes washers, etc.; and consumer electronics such as televisions and computers).

RECS is published every few years by the EIA, and administers hundreds of questions to residents about their home characteristics, device ownership, usage patterns, energy consumption (through monthly utility bills), and household demographics. Thousands of households are surveyed as part of this effort. RECS is designed to represent the U.S. general population. With this information, it is possible to estimate the numbers of various devices in homes and their correlations with demographics (such as income, or region of the country). AHAM and Appliance Magazine data are published annually and can be used to track historical shipments of appliances and forecast future shipment growth. More fine-grained (e.g., monthly by specific device model number) shipment data are available from NPD Group. For consumer electronics, data sources including The Nielsen Company, IMS

Research, and DisplaySearch can be used to estimate annual device shipments, numbers of devices in homes, and usage.

Despite the abundance of information that these sources provide, there remain important data gaps, in some cases making the estimate of potential national energy savings for specific devices very uncertain. The major limitation of RECS is that it covers a wide range of devices; therefore its questions are sometimes too general to provide the information needed for detailed calculations. For instance, the latest RECS survey (RECS, 2009) indicates the number of refrigerators and freezers in a home along with door style, defrost technology (used to identify product classes) and some capacity information, but the latter information is divided into fairly coarse bins. Also, it has no information about the type of cooling technology used,[1] or the presence of other types of less common refrigeration products such as wine chillers or residential icemakers. These turn out to be crucial variables in developing economic models for analyzing the impacts of improved efficiency.

In response to this and other data needs, LBNL has recently begun gathering data using a low-cost, online survey approach (described in detail in Sections 2 and 3). The surveys sample a wide range of U.S. demographics; however, the online U.S. population does not necessarily match the general U.S. population. Therefore, we have developed two complementary methods (called post-stratification weighting, described in Section 3.5) that are applied to the online survey data to correct for demographic biases that may exist, by assigning weights to individual responses.

The purpose of this report is to validate the use of one or both of these methods. In particular, we sought to answer the following questions:

1. Are unweighted results from online surveys consistent with those obtained with more traditional surveys? If not, are online survey results more nationally representative after applying post-stratification weighting?
2. Does post-stratification weighting sufficiently correct for demographic differences between online surveys and more traditional surveys?
3. Which post-stratification weighting method performs best in correcting demographic distributions from online surveys?

Through the use of various statistical tests, we evaluated whether, and to what extent, the online survey approach and its demographic weighting methods can be used to obtain representative answers to household device ownership and usage. We used known distributions of demographics to perform the post-stratification weighting, and then compared weighted survey results for several key household device questions to reference data obtained by other representative sampling methods. This analysis helped to determine whether online surveys can be used to gather separate data on household device ownership and energy use that would otherwise be unavailable from existing data sources. In the future, the use of such weighted survey data can be used to develop meaningful estimates of residential device prevalence, purchase price, lifetime, capacity, technology

[1] There are at least three cooling technologies in use in residential refrigeration products: vapor compression (the most common), absorption cooling, and thermoelectric.

type, usage frequency, or other quantities of interest. The method has thus far been applied to two sets of surveys on microwave ovens (Williams et al., 2012).

2 Background

There are at least four types of survey methods: (1) telephone interviews, (2) in-person interviews, (3) mail-in surveys and (4) online surveys. During the time when the internet was not as easily accessible as it is today, the first three methods were most commonly used to conduct survey studies. However, despite researchers having more control over offline random sampling through these methods, they are significantly more expensive and time-consuming to conduct than online surveys. Once the internet became prevalent in households in the late 1990s, the U.S. internet population grew substantially. Since then, online surveying has gained popularity in survey sampling.

The number of internet users in the U.S. reached 245 million in 2011, about 78% of total U.S. population (Miniwatts Marketing Group, 2012). Compared to telephone and in-person surveys, online (and mail-in) surveys reach many people in only a little time and at a relatively low cost. However, online surveys may suffer from what is known as selection (or sampling) bias, which is a systematic error due to the non-random sampling of a population. This is due to the fact that the entire population is not equally likely to participate in (or even have access to) the survey, resulting in skewed population coverage. In the early days of internet surveys, the primary sampling issue was known as the "Digital Divide": internet coverage was concentrated in more affluent and educated households, and often times women, the elderly, and racial minorities were underrepresented in the survey results. Today, the "Digital Divide" problem has lessened significantly with the rapid propagation of internet access across all demographic groups. The U.S. Department of Commerce measured internet access by different ethnic groups in its *Current Population Survey* and found that internet usage has grown at about the same rate in all groups, which further narrows the usage gap (DOC, 2010). The "Digital Divide" is expected to largely disappear in the next decade, and even today, internet coverage—the people who can be reached on the internet—is adequate enough for most types of research studies.

Despite internet coverage no longer being the biggest issue in online sampling, another issue, called self-selection bias (whereby participants themselves decide whether to participate, rather than an impartial researcher or algorithm) remains an important one to be addressed when making statistical inferences. In most cases, internet survey participants are not randomly selected because participants, who become the sample selection pool, are usually "opt-in" volunteers and are generally not as representative of the total target population compared to data collected through probability-based sampling. In order to make online access panel data more representative, a weighting procedure has been frequently applied based on the demographic characteristics of each survey respondent. Weights are calculated to make the demographic distribution of the online respondent similar to that of the general population (Loosveldt and Sonck, 2008). This approach is sometimes called post-stratification, where each "stratum" refers to a

particular demographic subgroup of the entire sample, and can be weighted differently to reflect the known proportions of the population. Many studies investigated the difference between data from online survey and other survey tools and further examined how various weighting methodologies perform differently on online collected data (Duffy et al., 2005; Hill et al., 2007). Yeager et al. (2011) found that non-random samples are not as accurate as random ones; however, post-stratification weighting techniques improve the overall accuracy of survey results from non-random samples.

Currently, one commonly used platform to administer online surveys is Amazon Mechanical Turk (AMT), which is available through Amazon.com. AMT started in 2005 as a crowd-sourcing tool. This virtual workplace allows "requesters" to post Human Intelligence Tasks (HITs) and "workers" to pick tasks they want to complete in exchange for a certain amount of monetary compensation (called a "reward"). Those HITs usually require human discretion and action that cannot be replaced by computers, such as image identification, adding tags or flags, finding correct websites, language translation, or survey questionnaires. Roughly half of the more than 500,000 AMT users globally are from the U.S. (Paolacci et al., 2010; Amazon, 2011), providing a large, diverse subject pool, especially for U.S.-based research.

Although some doubts associated with the quality of surveys collected by AMT remain, it has gained popularity among social scientists as a source of experimental data. Several studies also developed algorithms to screen the results and determine the quality of the responses based on users' behavioral traces (Kittur et al., 2008; Rzeszotarski et al., 2011). For example, if the median answering time for a particular survey is 10 minutes, and event logs show that one worker only took 30 seconds to complete the survey, the algorithm would automatically treat it as a corrupted input and assign small weight on that particular response. This "fingerprinting" process enables the requesters to identify whom they should pay and which answers to include in the final output.

Besides the quality of the survey, there is also concern over omission of certain demographic groups in online surveys. However, Paolacci et al. (2010) demonstrated that the population of AMT is "at least as representative of the U.S. population as traditional subject pools," and Gosling et al. (2004) concluded that online surveys have been shown to be "relatively diverse with respect to gender, socioeconomic status, geographic region, and age…and are consistent with findings from traditional methods." It should be noted that the context of these remarks is with respect to psychology research, where traditional methods tend to include student convenience samples. The fact that AMT results are as good as or better than these traditional methods is encouraging, but neither Paolacci et al. nor Gosling et al. compared AMT to a truly random sampling method like RDD. Ipeirotis (2010) showed that the geographical distribution and race composition of workers generally match those of Internet users. However, when compared with the general U.S. demographics, they found that AMT workers are on average younger, more typically female, and have higher education levels and fewer children. These demographics are not representative of the general population, but all relevant demographic groups are still present, albeit with lower frequencies of occurrence. Therefore, weighting online panel data has become a common way to adjust survey results to match more closely to the general population.

There are many respondent characteristics that are highly related to the propensity to respond, and the idea of weighting is to assign different weights on each respondent based on their demographics so that the sample demographic distribution matches the known population. Rivers (2012) listed three widely-adopted practices for selection and weighting: (1) quota sampling, (2) iterative (or "raking") procedures, and (3) cell weighting. For our research, we pursued a combination of all three: we used a variant on quota sampling to increase the numbers of responses from specific demographic groups, and for post-stratification weights we pursued both iterative and cell weighting approaches (described in Section 3.5 below).

3 Methods

3.1 Data sources

3.1.1 Amazon Mechanical Turk

AMT was used to deploy surveys of refrigeration products (specifically, refrigerators and freezers[2]), televisions (TVs), and set-top boxes (STBs)[3] in U.S. households. We chose these particular device categories in part because they were ubiquitous (almost all homes have refrigerators and TVs) and represent two very different product categories (refrigerators and freezers are traditional "white good" appliances, whereas TVs and STBs are fast-changing electronic products). They also had some information available about them from trusted sources (described below) that could be used to compare with some survey question results.

3.1.2 Residential Energy Consumption Survey

RECS is published every few years by the EIA. Researchers visit the homes of thousands of randomly-selected volunteers, where they obtain answers to hundreds of questions about home characteristics, appliances, and demographics. The survey is designed to be a representative sample of U.S. households. Data from RECS is used for many purposes, by researchers both inside and outside of DOE. Among its more "official" uses is to inform national energy use projections that are published each year in the Annual Energy Outlook (EIA, 2012). RECS is considered to be a very trustworthy source of information, and in many cases is the only nationally-representative source of data available.

The most recent survey (RECS, 2009) contained more than 12,000 samples representing every Census region (McNary and Berry, 2012). Data were assigned weights (as part of the public data product) indicating the number of households each sample represented. RECS data were used as a basis for assigning weights to AMT survey data, using the demographic

[2] Plus some miscellaneous device categories that were not discussed in this report.
[3] These are devices that provide TVs with video content from a cable, satellite or internet service provider.

questions contained in RECS. In addition, we compared the numbers of refrigerators, freezers, TVs and STBs in AMT to the numbers in RECS.

3.1.3 IMS Research and National Cable and Telecommunications Association

IMS Research regularly publishes a database of cable, satellite and IPTV subscribers (IMS Research, 2012). The National Cable and Telecommunications Association (NCTA) also publishes the number of subscribers for the top 25 service providers each year (NCTA, 2012). As the two datasets were very similar, we used the average of the two for the top 25 providers, and IMS Research data for the remainder, to obtain the reference fraction of U.S. households subscribing to each major service provider. This was used to facilitate comparison to AMT data.

3.2 Survey design

Surveys were developed for deployment using the AMT platform, which administers a set of questions as a single webpage that had to be completed in one session. Both surveys shared a set of demographic questions, placed at the end of the survey, which were based on questions found in RECS (see below). Within each survey, both "general population" samples (all demographics) and demographic "subgroup" samples (e.g., only Black/African American race) were deployed, in order to collect adequate numbers of samples across all demographic groups.

A summary of the surveys deployed is found below in Table 1.

Table 1. Deployed AMT surveys used in this report

Survey code	Description
RP	Refrigeration products general ownership, with detailed questions about specific product types and use
TS	TV and STB ownership, with detailed questions about STB use

3.2.1 Inclusion of questions from other data sources

We used the RECS (2009) survey to provide the format and wording of most of the demographic questions used in our surveys, as well as its demographic data for weighting our surveys. The demographic questions included were:

- Zipcode (and for the TS survey, State)
- Gender
- Hispanic/Latino origin
- Race
- Highest education level
- Number of occupants by age
- Annual household income
- Type of home (for RP survey)

- Number of years in current home (for TS survey)

The last two questions, while collected, were not used for demographic weighting.

The following other questions from RECS were included in specific surveys in order to facilitate the direct comparison of survey results with RECS:

- RP: Number of refrigerators and number of freezers
- TS: Number of TVs and number of STBs connected to TVs

For the TS survey, we also included a question about the major service provider for TV/STB subscribers (cable, satellite and IPTV). This answer was validated using data from IMS Research (2012) and NCTA (2012).

3.2.2 Modifications to RECS questions

We modified some questions from how they were phrased in RECS in order to increase the accuracy of the responses. For instance, questions about the number of various types of refrigeration products in the home all had the following basic structure in RECS:

How many refrigerators are plugged-in and turned on in your home?

Number of Refrigerators: _____

We modified the format of these questions to ensure that certain types of devices were included, and others excluded. Based on the professional survey experience of our team, respondents tend to answer the last thing they read, so if the list of what to exclude immediately precedes the answers, some respondents may answer opposite to what is desired. For this reason, we repeated the list of what to include, and also repeated the question (simplified and rephrased) to ensure that the question is the last thing read before the answers are presented:

How many <u>refrigerators</u> are plugged in at your home right now?

DO NOT INCLUDE:

- Stand-alone freezers
- Stand-alone icemakers
- Stand-alone wine/beverage coolers

INCLUDE:

- Full-size refrigerators
- Compact refrigerators
- Refrigerators with separate freezers, automatic icemakers, or wine/beverage cooler compartments

Check the number of refrigerators:

- None
- 1
- 2
- 3
- 4
- 5 or more
- Don't know

We also ensured that every question had a "Don't know" or "Decline to state" option, to provide respondents with the ability to answer every question even if they did not provide information. This was important both for addressing possible discomfort when answering demographic questions (race, household income, etc.), as well as distinguishing respondents who skipped questions (answer left blank) from those who answered the question but did not provide useful information.

In addition, some of the demographic questions were phrased differently than in RECS. Specifically:

- We avoided the term "householder" and instead asked about the person completing the survey.
- For the question about race, some answers that were chosen very infrequently in RECS (e.g., Alaskan Native) were replaced with combined categories. Also, because there was a separate question about Hispanic origin (as in RECS), we eliminated the option of also indicating "Hispanic" in the question on race, because this option was seldom used in RECS responses and in our opinion needlessly confused the results. For the TS survey only, instead of allowing the respondent to check multiple races, we allowed only one response but provided a "Two or more races" response to take care of those who considered themselves part of more than one race.
- We asked for the total number of household occupants differently than in RECS:
    - AMT: "How many persons live in your household for at least six months of the year? Please include yourself in that number."
    - RECS: "Including yourself, how many people normally live in this household? Do not include anyone who is just visiting, those away in the military, or children who are away at college."
- The way we asked about the ages of occupants was different from RECS, which asked for the age of each household member in order of decreasing age. In our approach, we asked the respondent to indicate the number of occupants within each age range (0-9, 10-19, etc.). We also provided an "age unknown" category to account for those where age may be uncertain.

3.2.3 Inclusion of "cheater" questions to increase data quality

Not all respondents answered honestly or accurately. After some initial surveys were deployed, we noticed that a small minority of respondents appeared to be providing strange answers to many questions, but we could not prove that their answers were

"wrong." For subsequent surveys, including those reported on here, we introduced a number of non-topical questions we termed "cheater" questions. These were designed so that any U.S. resident would be able to answer them easily, unless they were distracted or deliberately trying to confound the survey. The questions were mildly disguised by embedding them among topical product questions, with incorrect answers that often strongly resembled those of the surrounding questions. Those who answered one or more "cheater" questions incorrectly were eliminated from further analysis. Examples of such questions are summarized below:

- **How many bottles of wine are there in a dozen?** (Choices: 1, 2, 6, 12, 24, 50 or more, Don't know)
- **How many days are there in a month?** (Choices: Less than 5 days, at least 5 and less than 15 days, at least 15 and less than 25 days, at least 25 and less than 35 days, at least 35 and less than 45 days, at least 45 days, Don't know)
- **Who is the current president of the U.S.?** (Choices: "Obama" embedded in a number of refrigerator or STB brand names)

We also included two questions meant to catch "cheaters" as well as to double-check that the answers provided two different ways actually matched. The question concerned the number of full-time occupants living in the home. We asked for the total number as well as the number in each of several age bands (including an "unknown age" band). The sum of the age-based responses was compared against the response to the total number of occupants. Responses that differed by more than ±1 (to account for honest mistakes in arithmetic) were classified as "cheaters" and eliminated from further analysis.

Finally, for the TS survey, we identified invalid zip codes and eliminated those responses from further analysis.

3.2.4 Additional demographic subgroups

In order to correct for biases in the sampling of demographic groups in AMT, one or more demographic subgroup surveys were deployed to increase numbers of under-represented demographics (a form of quota sampling). These were done in addition to deploying a survey that sampled the entire population of possible respondents. Figure 1 shows typical unweighted general population AMT demographics (from the RP survey) in comparison with (weighted) RECS data. Circled items indicate demographic categories with significant deficits (i.e., where AMT populations are approximately half or lower than RECS), indicating a possible need for demographic subgroup sampling. Note that AMT data shown did not include "Decline to state" answers.

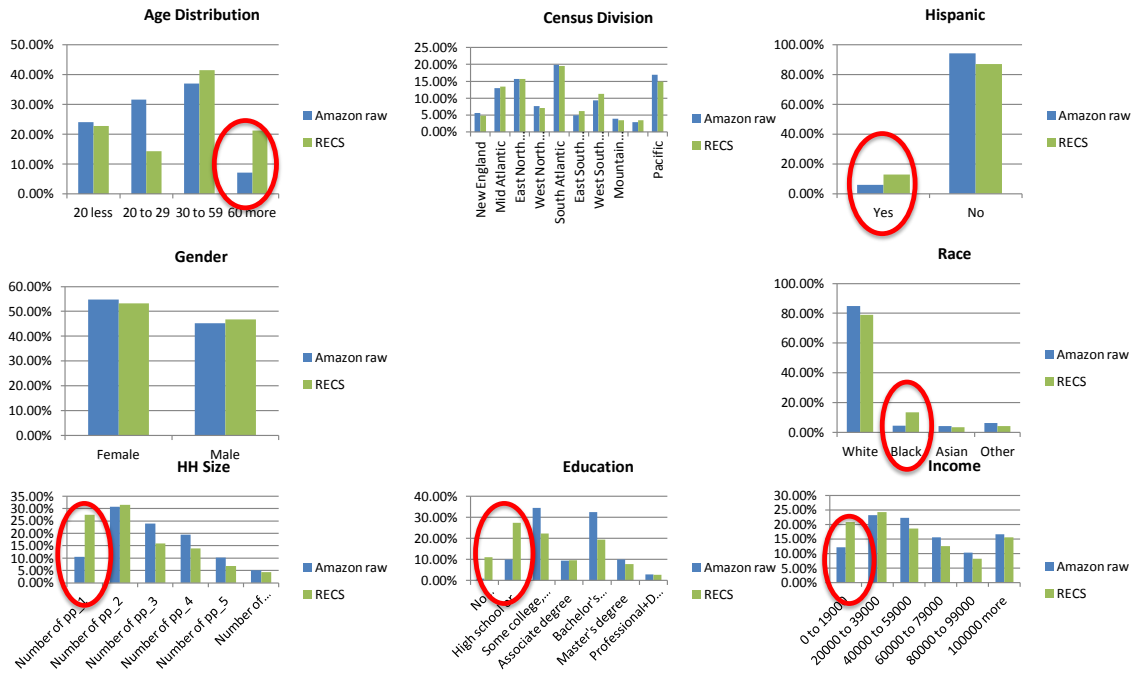

Figure 1. Comparison of demographic distributions in unweighted AMT RP and (weighted) RECS general population data. Circles indicate those categories with significant deficits (AMT populations approximately half or lower than in RECS).

Specifically, we found that the following demographic groups were generally under-represented in the unweighted AMT data by about a factor of two or more compared with RECS:

1) Black/African American households
2) Households with persons age 60 and older
3) Respondents with no college education
4) One-person households
5) Hispanic households
6) Low-income households (<$20,000/year)

For the RP and TS surveys, we focused on the first three (black/African Americans, age 60+ households, and respondents without a college education) that had at least three times smaller populations than RECS and were therefore the most deficient compared to the general population. By including the additional surveys, the populations of these demographic subgroups were brought to within a factor of two of the RECS populations. Detailed tables showing the proportion of responses from the RP survey with and without demographic subgroup data are shown in the Appendix (Section 9.1)

3.2.5 Qualification language

All surveys also included a header that clearly announced the qualifications for taking the survey. Responses of those who did not adhere to the qualifications were eliminated. The RP survey header is shown below:

Qualifications: U.S. residents at least 18 years old.

Please answer honestly and accurately! We have provided plenty of time for you to answer every question carefully.

NOTE: You will NOT GET PAID if you do not qualify for this survey or answer all questions that you are NOT asked to skip. Also, due to the size of our research study, we may take up to 21 DAYS to pay you.

For the TS survey, we further targeted the portion of the population who owned targeted devices (e.g., TV and STB), were the head of the household, and were the person most responsible for consumer electronics purchases:

To participate in this survey, you must:

- Be 18 year or older
- Be the head of the household
- Be the person most responsible for consumer electronics purchases
- Own a set-top box that is connected to a TV

NOTE: You will NOT GET PAID If you do not qualify for this survey or If you do not answer all questions that you are NOT asked to skip. Also, due to the size of our research study, we may take up to 21 DAYS to pay you.

For surveys where a specific demographic subgroup was targeted (e.g., no college education), in addition to identifying clearly in the survey title which demographic group was required (e.g., "Refrigeration Products Survey for people who never attended college"), an additional warning was provided in the survey header:

Qualifications: U.S. residents at least 18 years old, who have NEVER ATTENDED COLLEGE. If you have attended college, even if you did not graduate, you DO NOT QUALIFY for this survey and we will NOT approve it.

Finally, we included warnings about taking a survey more than once, even if they qualified for a demographic subgroup. Such "duplicates" were identified by matching their worker IDs and eliminated from further analysis. For the TS surveys, we explicitly included the HIT IDs (unique identifiers associated with each survey launched), as in the shown below:

If you have already taken the survey titled "Household Television and Set-Top Box Questionnaire" (with or without another demographic group specified), HIT-ID "2WLQ0JG5TYMN7MENPY69WSSIEWGKGW", "21NDD8XMB3Q34PGNRJKOAT4EVAZQFO","2MFH0JPPSI2KT45XDEY5OLM7EHXOIY", you CANNOT take this survey. Duplications will be identified and will NOT BE PAID.

3.3 Survey deployment

3.3.1 Logistics

We typically began with a test of 100 responses, to ensure that responses received were reasonable (e.g., that the questions asked were being correctly interpreted), and that the majority of respondents were paid an adequate amount based on the time spent answering the survey (see below). This amount was sometimes subsequently adjusted before launching the full survey. The time limit was also examined to ensure that every respondent in the test had ample time to complete the survey, and we adjusted the time limit if necessary.

The general population survey was launched first, followed by the demographic subgroup surveys once enough demographic data had been accumulated to validate the need for demographic subgroups. In some cases, demographic subgroups were not launched due to adequate demographics or time constraints.

3.3.2 Costs and speed

AMT reports that most workers expect to make $6/hr. on average, but surveys that pay above this amount will be more popular and therefore complete faster. We decided to adopt a policy where 90% of respondents were paid at least $6/hr. Given the typical distribution of completion times, this resulted in the median response-time worker earning $10-12/hr. As a rough guide, this translated into a reward of approximately $0.25 per 10 questions (depending on complexity), with the average full survey paying about $1.50. For some surveys, particularly those that were targeted to specific demographic subgroups, we increased the reward to encourage participation. The amount was based on the observed participation rates of the general population surveys and the typically lower participation rates in some demographic subgroups, and in some cases was up to twice the reward for the general population surveys. Most surveys completed their targeted number of responses (see below) within 3 weeks of launching.

3.3.3 Target numbers of samples

We aimed for at least 2,500 final responses or ±1% accuracy, assuming normal binomial statistics (see Section 3.6.1) for each targeted product survey. This accuracy level was partly driven by affordability; as we aimed to spend less than $5,000 per survey (including all demographic subgroups and discarded responses), at $1.50 per response, plus Amazon 10% overhead, we found that we could obtain approximately 3,000 gross responses within our per-survey budget.

3.4 Filtering

Several categories of responses resulted in exclusion from analysis:

- Non-qualified responses (did not own the required device or match the required demographics)
- Duplicate responses (worker ID found in more than one survey within the set)
- Responses with excessive skipped questions (3-10 skipped questions, depending on the survey)
- Answered one or more cheater questions incorrectly

Finally, we made a limited number of modifications to the data when:

- Respondents e-mailed us with corrected data
- We identified misspelled brand names, etc. in the survey and made corrections

We refer to the survey data following filtering as unweighted (filtered) data.

3.5 Demographic weighting

We developed two distinct approaches for weighting the demographic survey data. Both compared unweighted AMT demographic distributions to a reference dataset (e.g., RECS) and applied weights to make them resemble the reference distributions as closely as possible. To help with visualization, Figure 2 below provides a cartoon illustration showing the demographic variables as a cube that represents a larger, multi-dimensional "hypercube," where each dimension is one demographic variable, and each division of a given dimension represents a variable choice (e.g., for the number of occupants: 1, 2, 3, etc.).

One method ("sequential") applies weights iteratively, based on distributions of single demographic variables one at a time in sequence, while the other method ("simultaneous") applies weights based on several demographic variables at the same time. Both methods result in individual cell weightings, and is described in detail below.

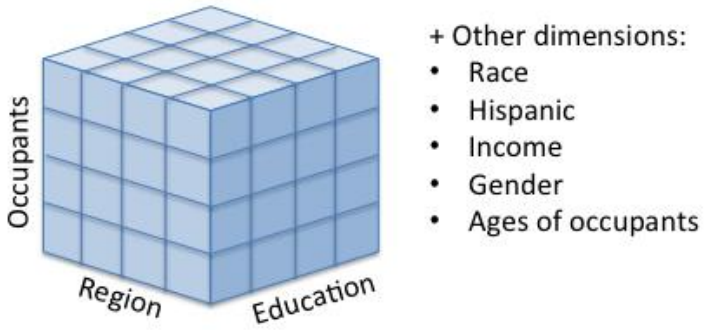

Figure 2. Cartoon representation of demographic variable "hypercube"

3.5.1 Sequential weighting method

In the sequential or iterative method, demographic distributions were compared on one demographic variable at a time, with weights assigned based on the ratio of population proportions in RECS versus AMT. Weights are assigned to each response in that particular demographic category, and are then used to calculate demographic distributions for the next demographic variable, from which a second set of weights are assigned. This process then continues for each demographic variable under consideration (typically, eight variables). The procedure then repeats, iterating until the weight of each response changes by less than a threshold amount (usually set to 0.5%).

A cartoon illustration is shown below.

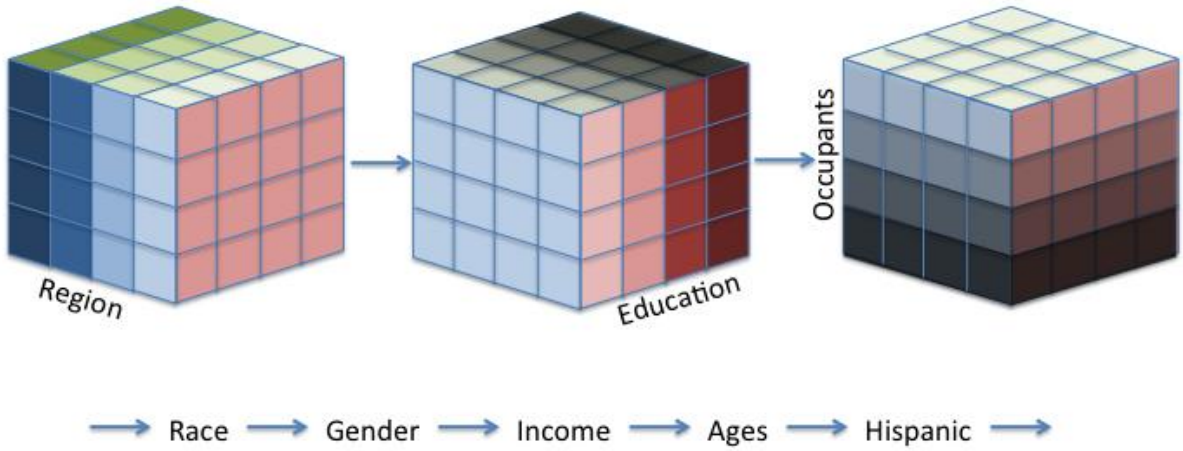

Figure 3. Cartoon illustration of the sequential demographic weighting method.

As an example, the first two steps of the process are shown below for income and education for the RP survey; the other six demographic variables (gender, race, Hispanic origin, number of occupants, ages of occupants, and geographic region) would then be considered in turn:

Table 2. Distribution of AMT RP income demographics.

Income	AMT unweighted	RECS	Weight	AMT weighted
Less than $20k	11.2%	20.9%	1.866	20.9%
$20k to $39k	22.3%	24.2%	1.085	24.2%
$40k to $59k	20.9%	18.6%	0.890	18.6%
$60k to $79k	14.8%	12.5%	0.845	12.5%
$80k to $100k	9.5%	8.2%	0.863	8.2%
More than $100k	15.2%	15.6%	1.026	15.6%

Table 3. Distribution of AMT RP education demographics before and after weighting by education.

Education	AMT unweighted	AMT weighted by income	RECS	Weight	AMT weighted by income and education
No schooling/diploma	1.14%	1.07%	10.55%	9.843	10.55%
High school or GED	17.17%	17.36%	27.39%	1.578	27.39%
Some college, no degree	31.19%	31.56%	22.24%	0.705	22.24%
Associate degree	8.74%	8.97%	9.42%	1.050	9.42%
Bachelor's degree	29.66%	29.31%	19.72%	0.673	19.72%
Master's degree	9.48%	9.12%	7.89%	0.865	7.89%
Professional or doctorate degree	2.62%	2.61%	2.79%	1.071	2.79%

The process continues iteratively until the final weight of each response in the sample converges to a final value. We found in practice that convergence takes several hundred iterations for a sample of roughly 3,000 responses.

As a variation on the above method, a "two-dimensional" method was explored where pairs of demographic variables were weighted at once, in order to account for first-order correlations between variables. This considerably more complex approach did not appear to provide superior results, however, and was abandoned.

3.5.2 Simultaneous weighting method

In the simultaneous method, one begins as for the one-dimensional iterative method, with a single demographic group for which weights are calculated based on the reference population. The next step, however, is unlike the iterative method, because it adds a second demographic variable while retaining the first; e.g., the sample becomes more finely divided. For instance, the method usually begins with geographic region; once weights are calculated for each region, the sample is further subdivided by number of occupants, so

that reference weights for a given geographic region *and* number of occupants is calculated. This process is then repeated with additional demographic variables until there are no reference samples corresponding to that combination of demographic variables. In the case where an AMT response is unknown (e.g., the respondent indicates "Don't know" or "Decline to state"), the method terminates for that response and retains its cumulative weight.

We chose demographic variables to correct the largest known biases in the AMT population. The order of the sequence was: region, number of occupants, race, number of 20-29 year-olds, and education. The remaining variables were left unweighted. Region was chosen as the first variable because there was a valid answer for every survey response, ensuring every response had an initial weight. Number of occupants also had very few invalid answers, and corrected the proportion of "Under 20 year-olds" in the age category. Experimentation with the order of the remaining variables determined that race was the most appropriate to weight next. When other variables, such as education, were placed before race, the correction to education was very similar to having it at the end, while the correction to race was significantly worse. The case was similar for the number of 20-29 year-olds category. This age group was chosen as its own category because it had a very strong bias, i.e., more than 50% of the unweighted AMT survey responses had at least one 20-29 year old, whereas in RECS less than 20% of households did. Income was left out, because education and income are highly correlated. Therefore, correcting for one typically corrects for the other, and education had fewer "Don't know/Decline to state" answers. Although there is a female bias in the AMT data, it is very slight and therefore was not explicitly addressed. Due to the finite number of responses in RECS, any additional demographic variables would subdivide the sample too finely, resulting in reference subsamples with few or no responses. This selection of variables was the result of much experimentation and represents our optimum solution thus far. Further experimentation may improve results slightly, but is unlikely to result in a large improvement.

Figure 4 illustrates this process schematically.

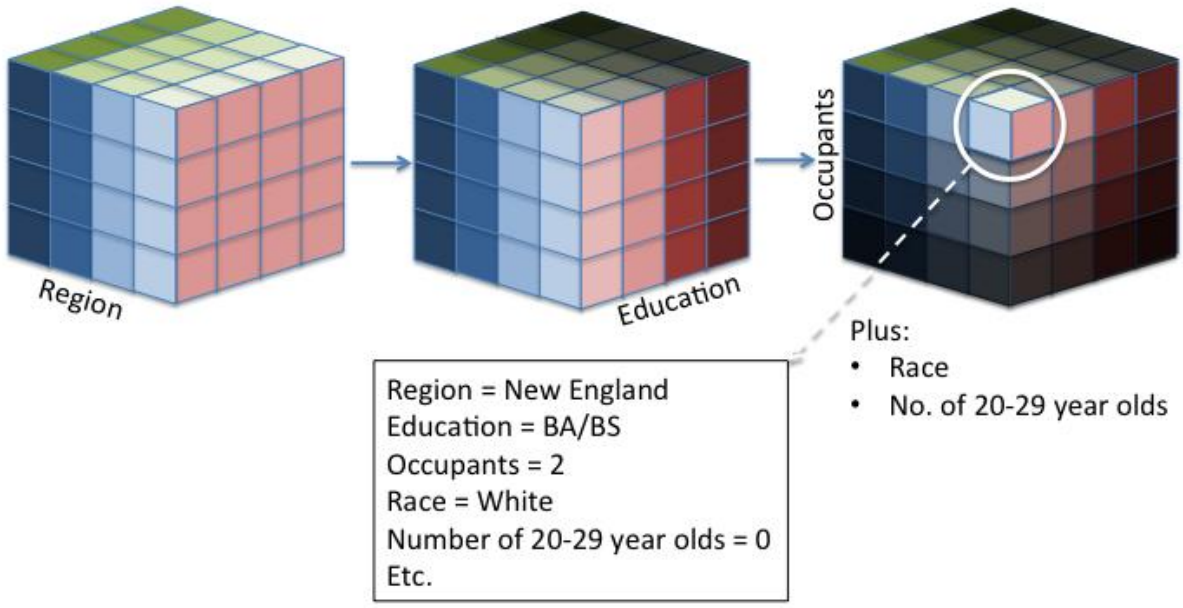

Figure 4. Cartoon illustration of the simultaneous demographic weighting method.

3.6 Comparison to reference data

In order to determine how well the results from AMT represent the U.S. population, we compared AMT survey results to data from sources that are considered to be representative of the U.S. population. We compared the proportions of numbers of refrigerators and freezers (as well as both simultaneously) from the RP survey, and of TVs and STBs from the TS survey, to the same proportions reported in RECS 2009. For all of these products except STBs, we also compared the average number of devices per household for various demographic subgroups of the full sample. Next, we compared the proportions of content providers from the TS survey to data from IMS Research and NCTA. Finally, we calculated the Pearson's chi squared test for distributions of proportions of numbers of refrigerators, freezers, refrigerators and freezers, and TVs. All comparisons are outlined in Table 4.

Table 4. Comparisons to reference data. The X's indicate comparisons we performed.

		Comparisons Performed		
Parameter	**Reference Data**	**Differences of Proportions**	**Distributions of Proportions (Chi squared)**	**Differences in Average Number by Demographics**
RP survey				
Refrigerators	RECS	X	X	X
Freezers	RECS	X	X	X
Refrigerators and	RECS	X	X	

freezers				
TS survey				
TVs	RECS	X	X	X
STBs	RECS	X		
Primary service providers	IMS Research and NCTA	X		

We performed all of the comparisons for AMT data unweighted, and weighted using the two methods (sequential and simultaneous). This allowed us to investigate the agreement between AMT and the reference data, as well as to compare the performance of the different weighting methods to each other and to the unweighted data.

3.6.1 Difference of proportions

We calculated the differences between single proportions in AMT and the corresponding proportions in the reference data as:

$$p_{x,AB} = p_{x,A} - p_{x,B}$$

where

$p_{x,AB}$ = difference between proportions of x in AMT and reference
$p_{x,A}$ = proportion of x in AMT
$p_{x,B}$ = proportion of x in the reference (e.g., RECS)

We calculated the standard error of the difference between proportions as:

$$\sigma_{x,AB} = \sqrt{\sigma_{x,A}^2 + \sigma_{x,B}^2}$$

where

$\sigma_{x,AB}$ = standard error of difference between proportions of x in AMT and reference
$\sigma_{x,A}$ = standard error of proportion of x in AMT
$\sigma_{x,B}$ = standard error of proportion of x in the reference

We used the normal approximation to the binomial distribution (Wikipedia, 2012a) to calculate the standard error for a single proportion as:

$$\sigma_x = \sqrt{\frac{p_x(1-p_x)}{N}}$$

where

σ_x = standard error for a single proportion
p_x = a single proportion
N = the total number of responses in the sample

For instance, if p_x = 0.5 and N = 2,500, then σ_x = 0.01.

We then used the standard error of the difference between proportions to calculate a confidence interval for each difference. We calculated the lower and upper bounds of the confidence interval as:

$$lower\ bound = p_{x,AB} - z\sigma_{x,AB}$$

$$upper\ bound = p_{x,AB} + z\sigma_{x,AB}$$

The values $-z$ and z are the standard scores bracketing the desired probability in the center of the standard normal distribution (Wikipedia, 2012b, 2012c). For example, for a 95% confidence interval, z = 1.960 because –1.960 and 1.960 are the standard scores for which the standard normal cumulative distribution function equals 2.5% and 97.5%, respectively.

We used the Bonferroni correction (Bailey, 1980; Cherry, 1996; Wikipedia, 2012d) to create individual confidence intervals that result in a 95% confidence level across all levels within a group. We calculated the confidence level of individual confidence intervals as:

$$C_i = 1 - \frac{\alpha}{k}$$

where

$$\alpha = 1 - C_g$$

C_i = the confidence level of an individual interval
C_g = the group-wise confidence level (i.e., 95%)
k = the number of levels in a group

We refer to these as Bonferroni-corrected confidence intervals, which provide a more conservative estimate of the uncertainty in the quantities than the individual 95% confidence intervals.[4] Table 5 outlines the individual confidence levels and values of z used for each comparison.

[4] Some researchers have pointed out shortcomings with this approach, which are improved with more elaborate formulations, such as Bailey (1980). Cherry (1996) compared Bailey's method with the Bonferroni-adjusted binomial distribution and found important differences for $N < \sim 500$ and $k > \sim 10$, but results were almost indistinguishable otherwise. In our cases, we are within this latter regime for all but the question on the number of service providers ($k > 25$), and take appropriate precautions when evaluating these results.

Table 5. Details of the individual confidence intervals reported.

Parameter	Number of levels (*k*)	Confidence Level of Individual Intervals (C_i)	*z*-value
RP survey			
Refrigerators	6	99.1%	2.638
Freezers	6	99.1%	2.638
Refrigerators and freezers	24	99.8%	3.078
TS survey			
TVs	5	99.0%	2.576
Set-top boxes	5	99.0%	2.576
Service providers	13	99.6%	2.891

3.6.2 Distribution of proportions

We used Pearson's chi-squared (χ^2) test to compare the distribution of proportions between AMT and the reference data. This test returns the probability p of observing the calculated value of the test statistic, or a greater value, when both samples are drawn from the same underlying distribution. We used a value of $p \leq 0.05$ as the criterion for a statistically significant difference.[5]

3.6.3 Average number of devices per household

We calculated the average number n of a device per household by:

$$n = \sum_{x=0}^{x_{max}} x \cdot p_x$$

where x is the number of devices per household reported by a proportion of respondents, x_{max} is the maximum number of devices per household reported, and p_x is the proportion of respondents who reported x devices per household.

We calculated the standard error σ_n of n as:

$$\sigma_n = \sqrt{\sum_{x=0}^{x_{max}} x^2 {\sigma_x}^2}$$

[5] Generally it is recommended that the chi-squared test be used for proportions such that the actual number of responses is 5 is greater; for our AMT samples, with $N \sim 3000$, this corresponds to a proportion of ~0.2%.

We used the normal approximation to the binomial distribution (Wikipedia, 2012a) to calculate the standard error for each single proportion, σ_x, as:

$$\sigma_x = \sqrt{\frac{p_x(1-p_x)}{N}}$$

where N is the total number of responses in the sample.

We calculated 95% confidence intervals for the average numbers and the differences between averages. We calculated the lower and upper bounds of the confidence intervals as:

$$lower\ bound = n - 1.960\sigma_n$$

$$upper\ bound = n + 1.960\sigma_n$$

We calculated these quantities for the entire sample as well as eight demographic subgroups (income, education, gender, race, Hispanic origin, number of occupants, ages of occupants, and geographic region).

3.6.4 Interpretation of differences

When interpreting the differences observed between the AMT results and the reference data, we consider three additional criteria when making conclusions about our findings.

The first criterion is the unquantified uncertainty in the reference data. The confidence intervals plotted are based on the reported counts for each category in RECS or IMS Research/NCTA. In addition to the uncertainty derived directly from these counts, it is likely that both data sources have uncertainty in their data collection processes. This level of uncertainty is not reported, and therefore is hard to quantify. To account for this, we will consider differences less than approximately 1.5 to 2 times the size of the calculated and plotted confidence intervals as "minor," and differences larger than this as "major."

The second criterion is the meaningful effect size. We understand that it is impractical to acquire measurements with very high levels of precision. As a result, we accept that there is a minimum effect size (e.g., difference in proportions) that is meaningful for our purposes. Below this value, the difference is not very important in the analysis for which the AMT data will be used. For proportions, we consider the meaningful absolute difference to be 2%. Therefore, we consider any differences in proportions between approximately –2% and +2% as "minor," and outside of this as "major." For average numbers of devices per household, we consider an absolute difference of less than approximately 0.1 as "minor," and greater than 0.1 as "major."

Finally, for chi-squared tests, while the common threshold for determining if two distributions are identical is $p \leq 0.05$ (95% confidence level), we considered results with $p \leq 0.05$ but $p > 0.01$ (99% confidence level) to be "minor," and $p \leq 0.01$ as "major."

4 Results

4.1 Raw surveys

The table below indicates the number of raw responses for each survey, the number of responses eliminated due to various criteria, and the final filtered response counts.

Table 6. Survey filtering statistics

	Survey	
	RP	**TS**
Raw responses	3,430	3,443
Eliminated responses*		
- Screening question disqualification**	0	368
- Cheater question answered incorrectly	277	782
- Excessive number of skipped questions	57	116
- Demographic subgroup disqualification	56	124
- Duplicate	81	188
Remaining filtered responses	3,021	2,295
Fraction of filtered to raw responses	88%	67%

* Some eliminated responses may count in several categories.
**For TS survey only (screening questions S1-S8)

Below one can find the number of filtered responses obtained from the general population surveys and the demographic subgroup surveys.

Table 7. Number of filtered responses obtained from the general population and demographic subgroup surveys

Survey Demographic	Survey	
	RP	**TS**
General Population	2,145	1,581
Black/African American subgroup	234	183
No college education subgroup	222	215
Age 60+ households subgroup	420	316
Total	3,021	2,295

4.2 Weight distributions

The distribution of post-survey weights can reveal important insights into the quality of both the weighting method and the underlying sample. For instance, distributions that are

very asymmetrical, with a small number of sample points receiving very high weights, may indicate a poor weighting scheme, as the results become dominated by a few points. Also, too many sample points with very low weights result in *de facto* exclusion from the analysis, and can indicate problems with the weighting method. Assuming the weighting method is performing reliably, the full range (ratio of highest to lowest weight in the sample) can also serve as a useful indicator of the degree of heterogeneity in the underlying sample. Early attempts to weight surveys using the sequential method often resulted in distributions with these symptoms, including samples with very low weights ($<10^{-3}$) and as a result, very large total ranges (>10,000).

In this section, we begin with an examination of the RECS sample, which also used post-stratification weights for each data point, and then examined the weight distributions between the two weighting methods for both surveys considered here.

4.2.1 RECS

The RECS data contained 12,083 samples, each with a weight representing the number of households it represented. To allow comparison with our AMT weights, we re-scaled the RECS weights so that they summed to the number of samples, rather than the number of U.S. households. Weights varied by a factor of 201 across the sample, with a minimum weight of 0.051, a maximum weight of 10.2, a median weight of 0.85, and an average weight of 1 (by definition[6]). Plots of the sorted weights and sorted cumulative weights are shown in Figure 5 and Figure 6, respectively. The lower half of the sample contributed 32% of the total weight, with the upper half contributing 68%.

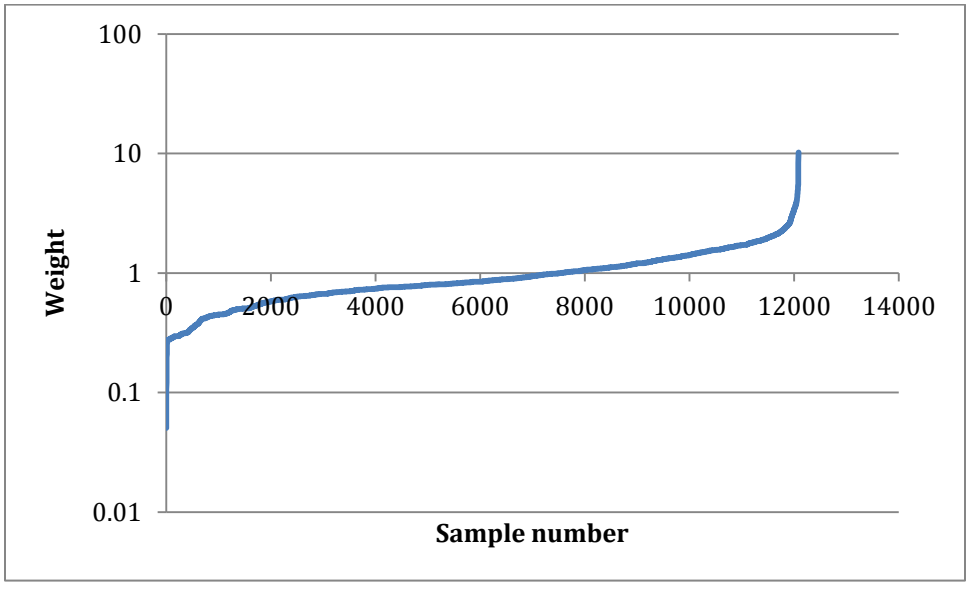

Figure 5. RECS weight distribution (vertical log scale)

[6] The weights are normalized so that their sum is equal to the number of samples (12,083 in this case). Thus, the average weight must equal 1, since the average is equal to the sum divided by the number of samples.

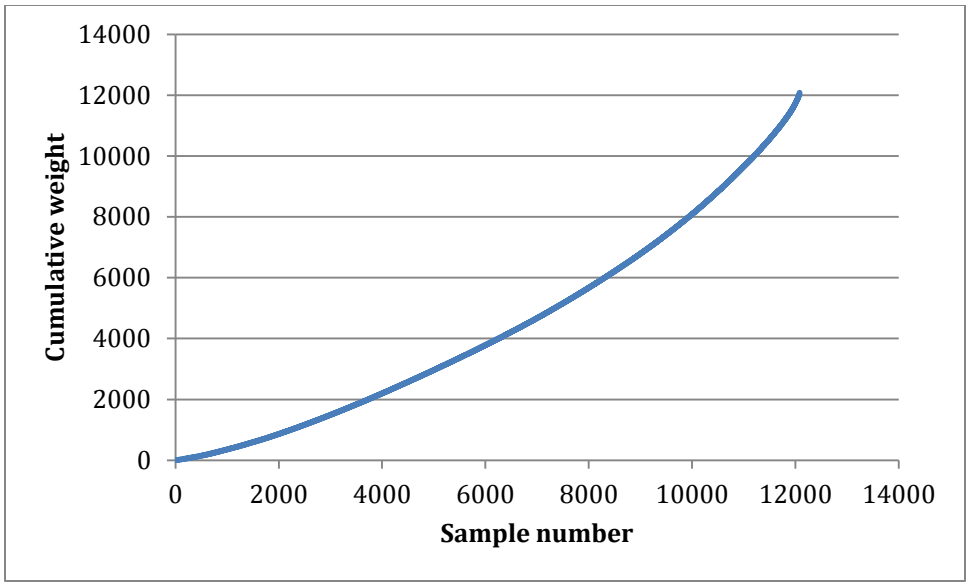

Figure 6. RECS cumulative weight distribution

4.2.2 RP survey

The sequential and simultaneous weighting methods for RP resulted in weight distributions that were somewhat larger than for the RECS data, with a range in weights across the sample of over a factor of 3000.[7] See Figure 7. In both cases, the minimum weight was approximately 0.01 and the maximum weight was somewhat less than 40. The median weight was 0.33 for the sequential method and 0.48 for the simultaneous method. The weight distributions were similar, except that the simultaneous method produced somewhat higher weights in the lower two-thirds of the samples; see Figure 8. Also, both methods produced cumulative weight distributions with more curvature than in RECS, with the lower half of the sample contributed 8% of the cumulative weight for the sequential method and 12% for the simultaneous method. While these fractions were not as large as found in RECS (32%), they were not very different between the two weighting methods, and were also similar to those found for the TS survey (see Section 4.2.3), so we concluded that it reflected the reality of samples obtained using AMT.

[7] For the sequential method, we split the RP sample into two groups (White and non-White race) and applied sequential weightings to each group separately in order to obtain this result. Without splitting the sample in this manner, we found that the range in weights was unacceptably large (>20,000), with non-White households receiving very low weights relative to the rest of the sample. Splitting the sample was, however, unnecessary with the simultaneous method, or with either method for the TS survey.

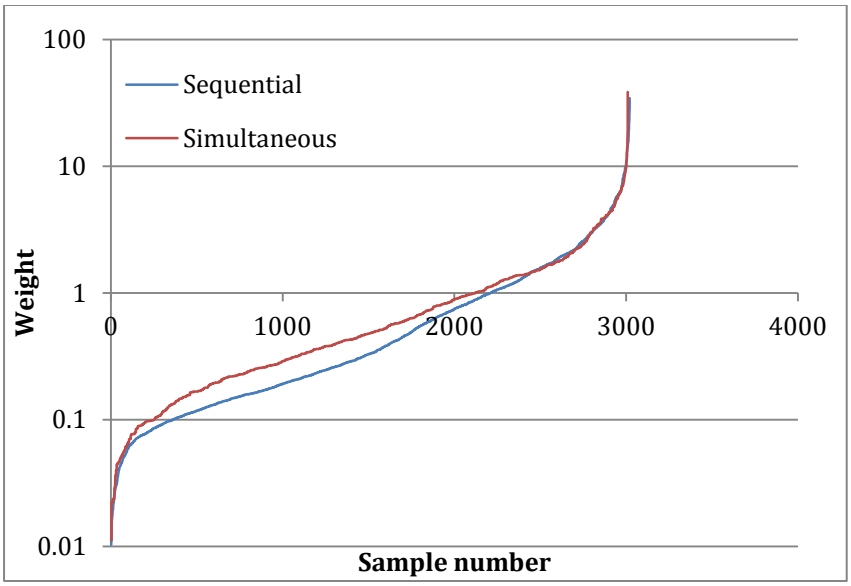

Figure 7. Comparison of weight distributions for RP survey using both weighting methods. Note vertical log scale.

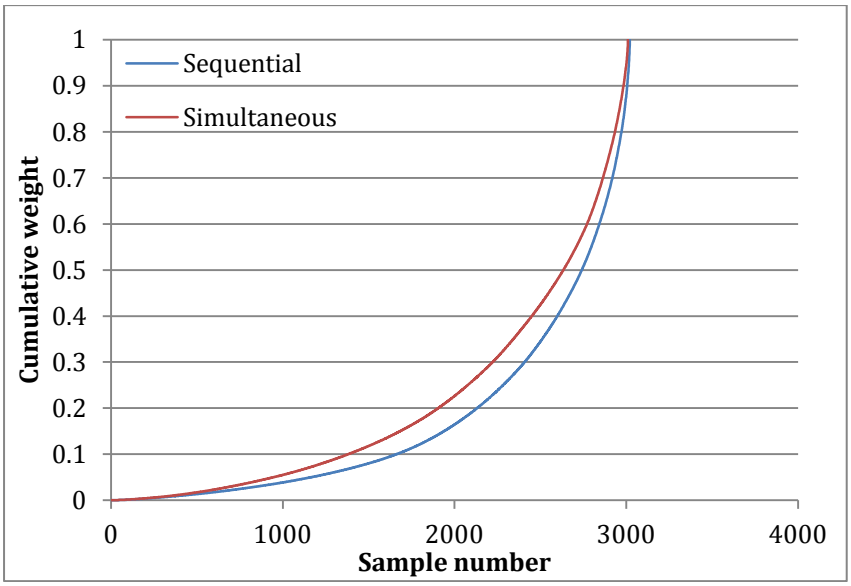

Figure 8. Comparison of weight distributions for RP survey using both weighting methods (normalized to 1)

Because the two distributions appeared similar, we also examined the correlations between the weights from the two methods. We found that the majority of weights lay along the 1:1 axis, but with considerable scatter; see Figure 9.

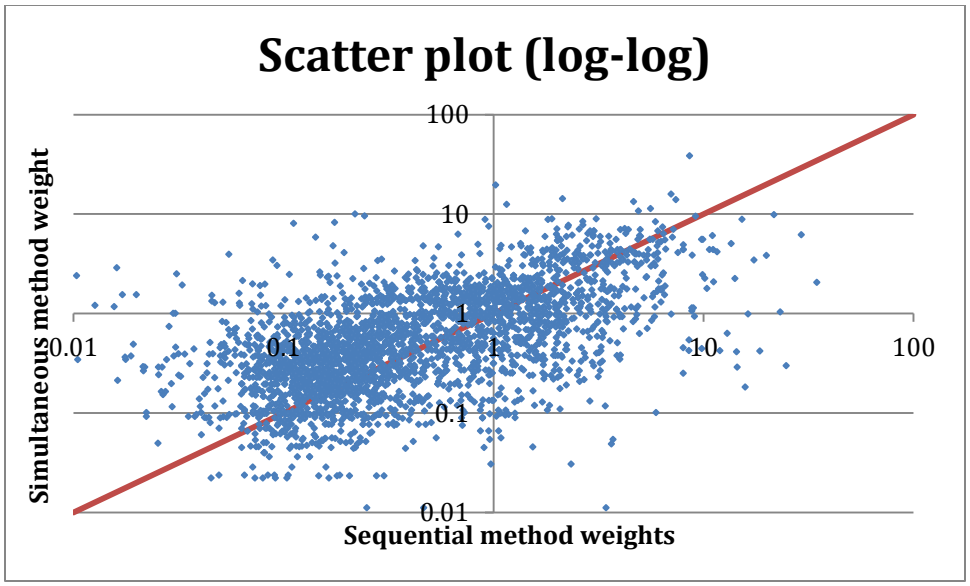

Figure 9. Comparison of calculated weights from the two methods. Reference 1:1 line is shown in red.

We also examined the difference in weights between the two methods, shown as a sorted distribution in Figure 10. We see that approximately 80% of data points changed by less than one, indicating that the two methods largely assigned similar weights, though with some important differences that become evident when we compare specific question results with RECS (see Section 4.4 below).

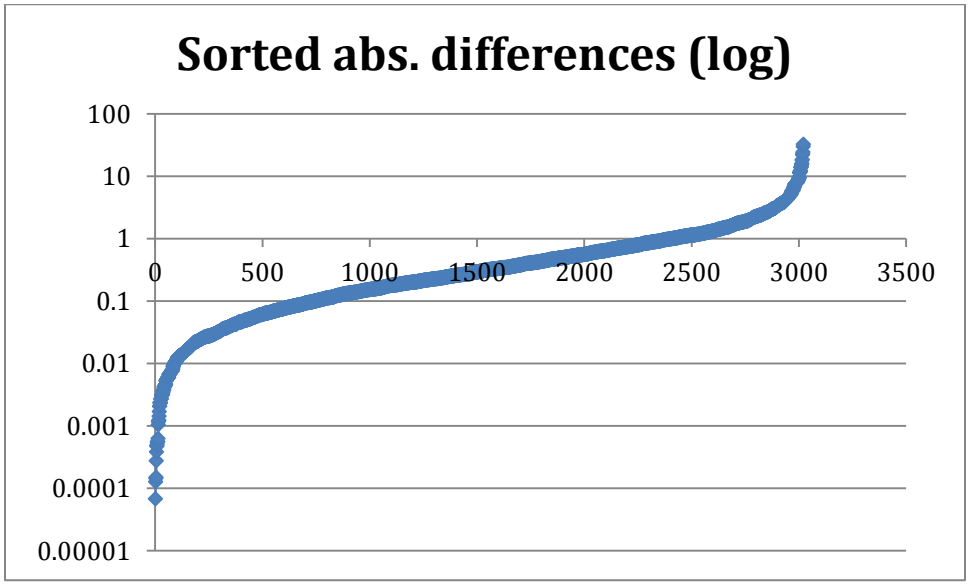

Figure 10. Sorted absolute differences in weights between the two methods.

4.2.3 TS survey

For the TS survey, the two weighting methods produce weight distributions that are much more similar than for the RP survey, as illustrated in Figure 11 and Figure 12. The minimum weight for this survey was approximately 0.03 for both weighting methods, and the maximum weight was 67 for the sequential method and 25 for the simultaneous

method, resulting in a range in weights across the sample of approximately 2000 and 900, respectively. The median weights were approximately 0.5 for both methods. The weight distributions were very similar, as were the cumulative weight distributions. As for the RP survey, the lower half of the sample contributed about 12% of the cumulative weight (for both weighting methods), as opposed to 32% in RECS.

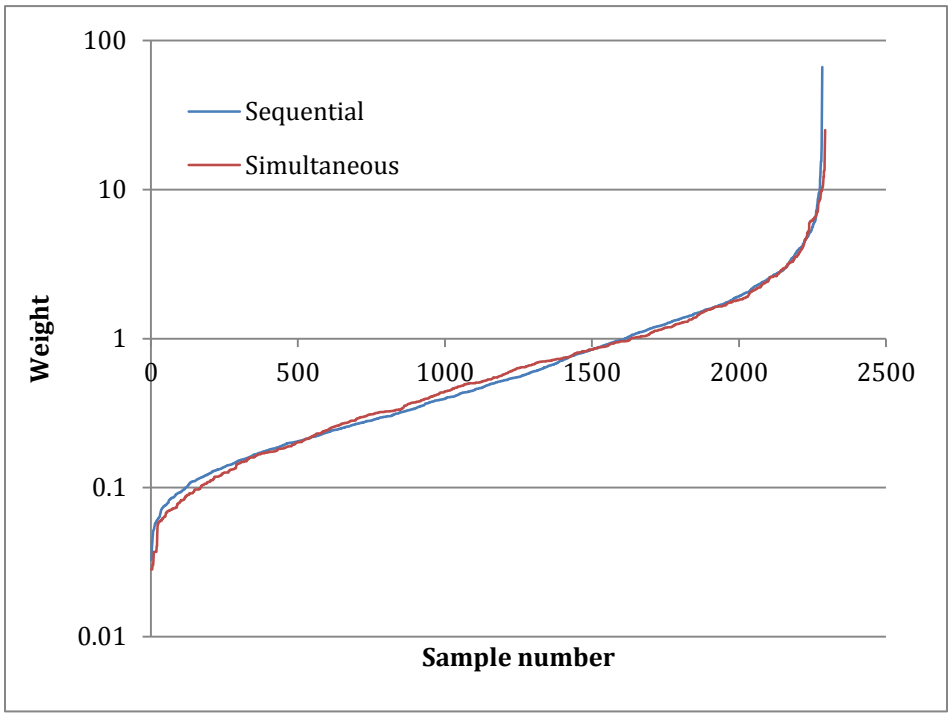

Figure 11. Comparison of weight distributions for TS survey using both weighting methods. Note vertical log scale.

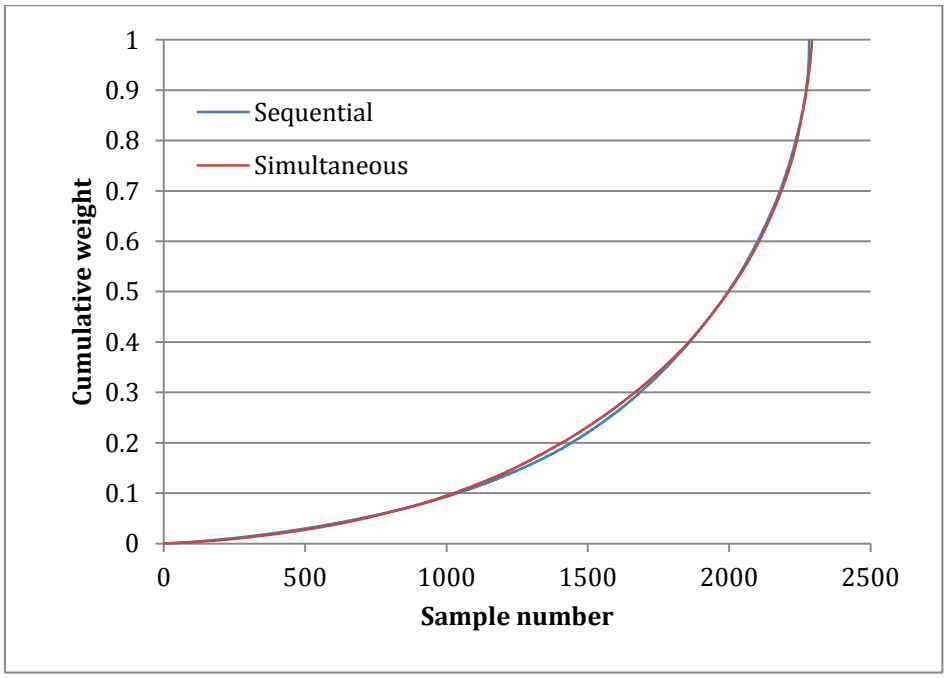

Figure 12. Comparison of cumulative weights for TS survey using both weighting methods (normalized to 1).

4.3 Weighted demographic distributions

As stated in Section 2, the purpose of post-stratification weighting of AMT surveys is to correct possible biases in survey results from a sample that does not reflect the demographic distribution of the general population. For example, respondents with little education are very unlikely to be sampled in AMT; therefore they are under-represented and need to be scaled up by assigning larger weights than people in other education categories. From Figure 1, one can see several differences in demographics between the AMT general population survey and RECS that subsequent demographic subgroup sampling was only partially able to correct.

The two weighting methods differed in how they weighted the samples to correct their demographic distributions. Figure 13 shows these demographic distributions for the unweighted AMT data, the AMT data weighted using the two methods, and the (weighted) RECS data.[8] The AMT RP survey was used in this example, but results for the TS survey are very similar.

[8] Note that the unweighted AMT RP data in Figure 13 is different from what is shown in Figure 1. While Figure 13 shows the full, unweighted AMT dataset including demographic subgroups, Figure 1 shows only unweighted data from the general population survey.

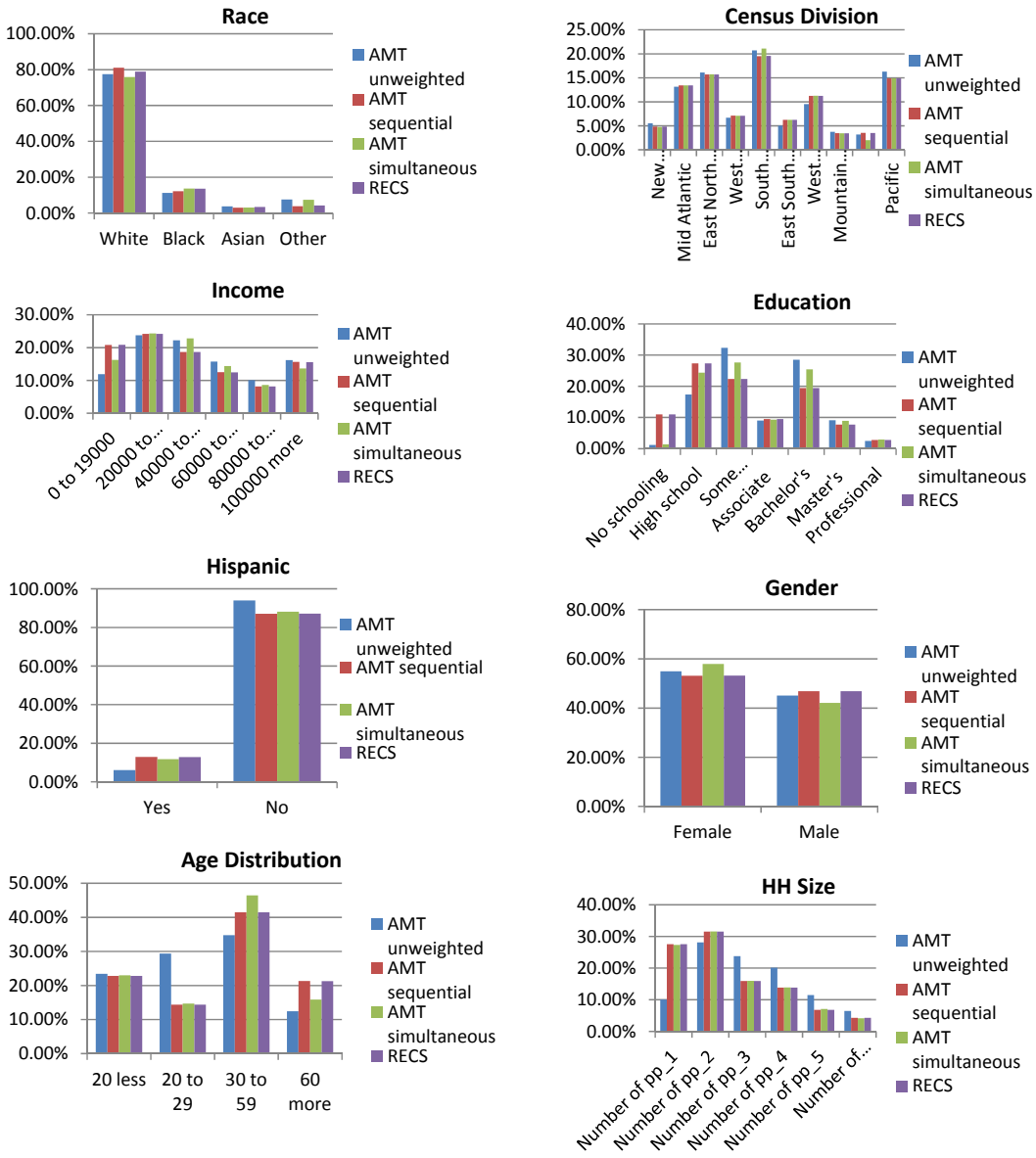

Figure 13. Comparison of demographic distributions in unweighted AMT RP, weighted AMT RP using the sequential and simultaneous weighting methods, and RECS.

Both weighting methods show marked differences from the unweighted AMT data. The sequential method iteratively adjusted the weights of all demographic variables until it achieved convergence below a specified threshold; as a result, the weighted AMT demographic distributions matched those of RECS very closely in each category.

By contrast, the simultaneous method adjusted sample weights once to produce an exact match to the demographic distributions in RECS for some demographic categories but not others; as a result, agreement with RECS is not as close in these latter categories. Some of these differences arise from the omission of some sample points from multi-category weighting due to the omission of a demographic value ("Don't know/Decline to state"

response) at some stage in the process. Also, some differences in methodology exist. For example, the simultaneous method combined the Hispanic origin and race categories into a single variable that was weighted together, while the sequential method optimized these categories separately.[9] The main impact of this difference is that "White" has a slightly lower representation than in RECS, and "Other" has a slightly higher representation than in RECS, in the simultaneously-weighted AMT data. Also, as mentioned above, some demographic categories were left entirely unweighted, such as gender, age other than 20-29 year olds, and income. Moreover, for education, because of the small number of respondents indicating "No education" (did not complete high school) compared to RECS, this category was left unweighted, unlike the sequential method where it included along with the other categories of education.

4.4 Evaluation of RP results

4.4.1 Proportions of numbers of refrigerators and freezers

We first examined the proportions of the numbers of refrigerators and freezers separately, and then the proportions of the numbers of refrigerators and freezers simultaneously.

Figure 14 and Figure 15, respectively, show the numbers of refrigerators and freezers in RECS. Figure 16 and Figure 17 show the corresponding differences between AMT and RECS, for AMT data unweighted, and weighted using the two methods.

For refrigerators, we found that while both methods resulted in improvements over the unweighted data, they also produced some differences that lay outside the confidence intervals, probably indicating some small sample bias. Overall, the simultaneous method produced smaller differences from RECS than the sequential method. For the simultaneous method, the proportions of households with zero and three refrigerators were each larger than RECS by about 1%, which were statistically significant differences; however, the interpretive thresholds for confidence intervals and overall effect size (discussed in Section 3.6.4) were considered to be "minor."

For freezers, we found that both methods were improvements over the unweighted data, and resulted in similar differences from RECS that all lay within the confidence intervals.

[9] That is, respondents who identified themselves as both Hispanic and white, only counted towards Hispanic.

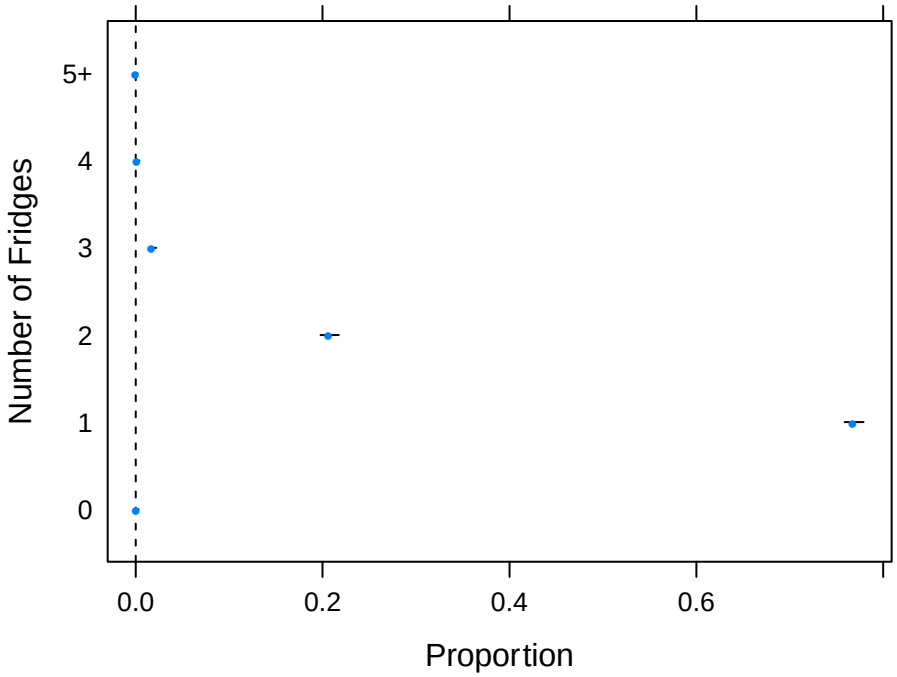

Figure 14. Numbers of refrigerators in RECS, with Bonferroni-corrected confidence intervals.

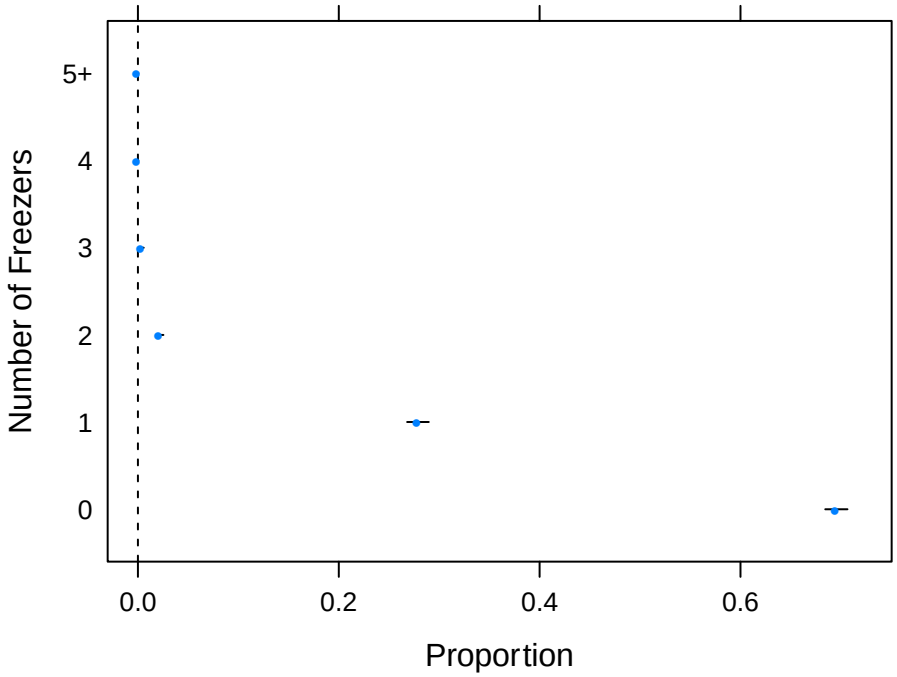

Figure 15. Numbers of freezers in RECS, with Bonferroni-corrected confidence intervals.

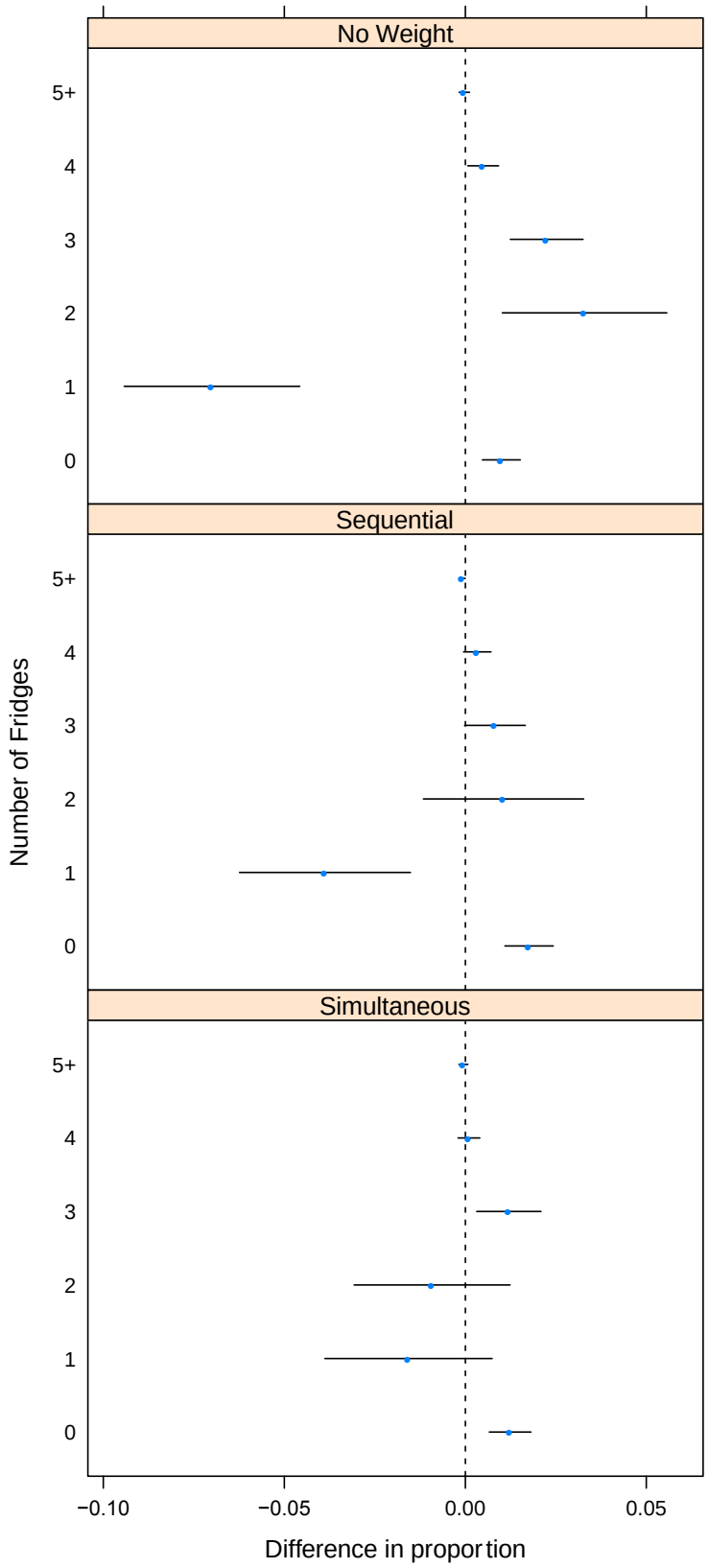

Figure 16. Differences in numbers of refrigerators between AMT RP and RECS, for unweighted data and the two weighting methods. Bonferroni-corrected confidence intervals are shown.

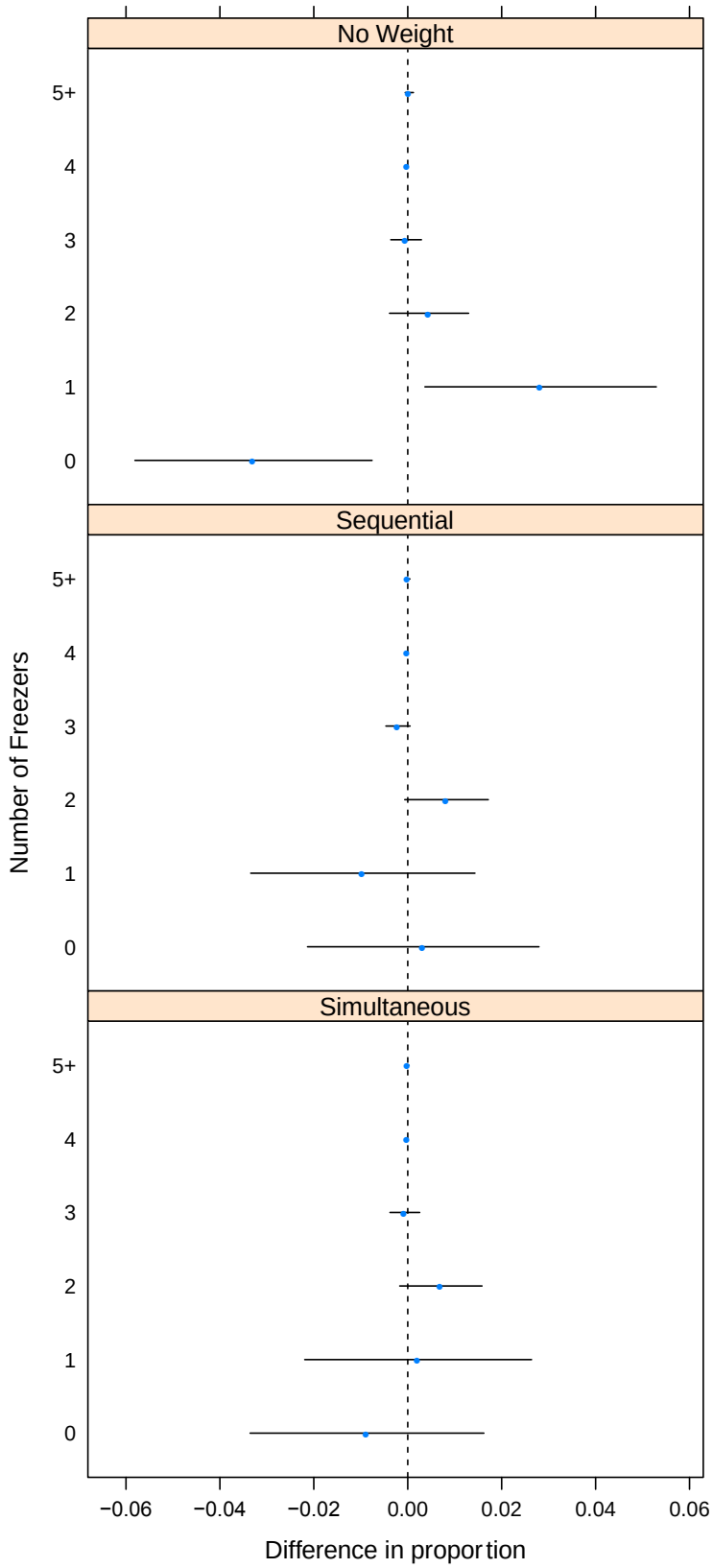

Figure 17. Differences in numbers of freezers between AMT RP and RECS, for unweighted data and the two weighting methods. Bonferroni-corrected confidence intervals are shown.

We next examined distributions of proportions of refrigerators and freezers simultaneously. Figure 18 shows the RECS proportions, while Figure 19 shows differences between AMT and RECS, for AMT data unweighted, and weighted using the two methods. Note that the vast majority (>99%) of proportions are found for homes with 1-3 refrigerators and 0-2 freezers.

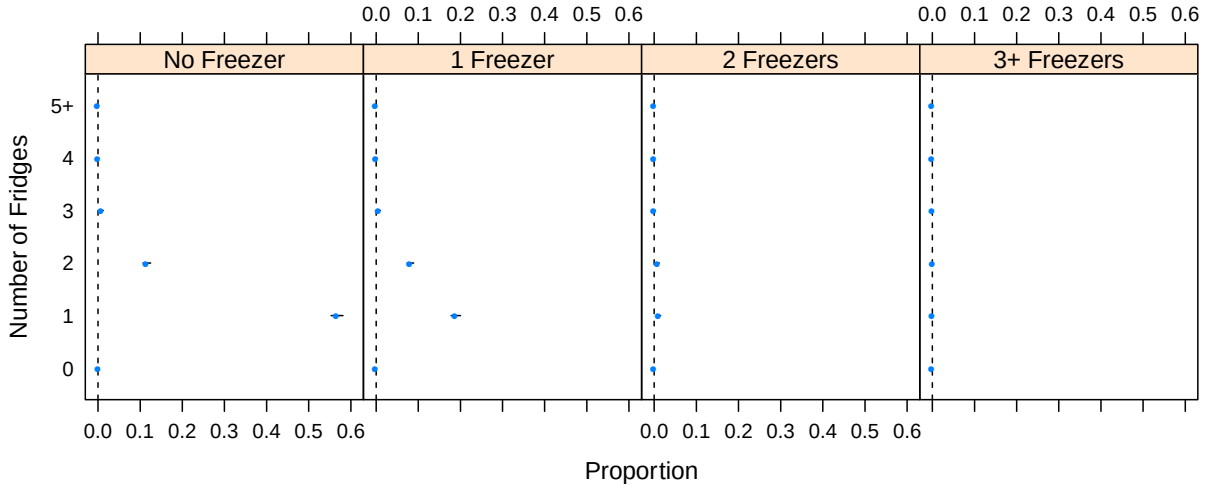

Figure 18. Proportions of numbers of refrigerators and freezers in RECS, with Bonferroni-corrected confidence intervals.

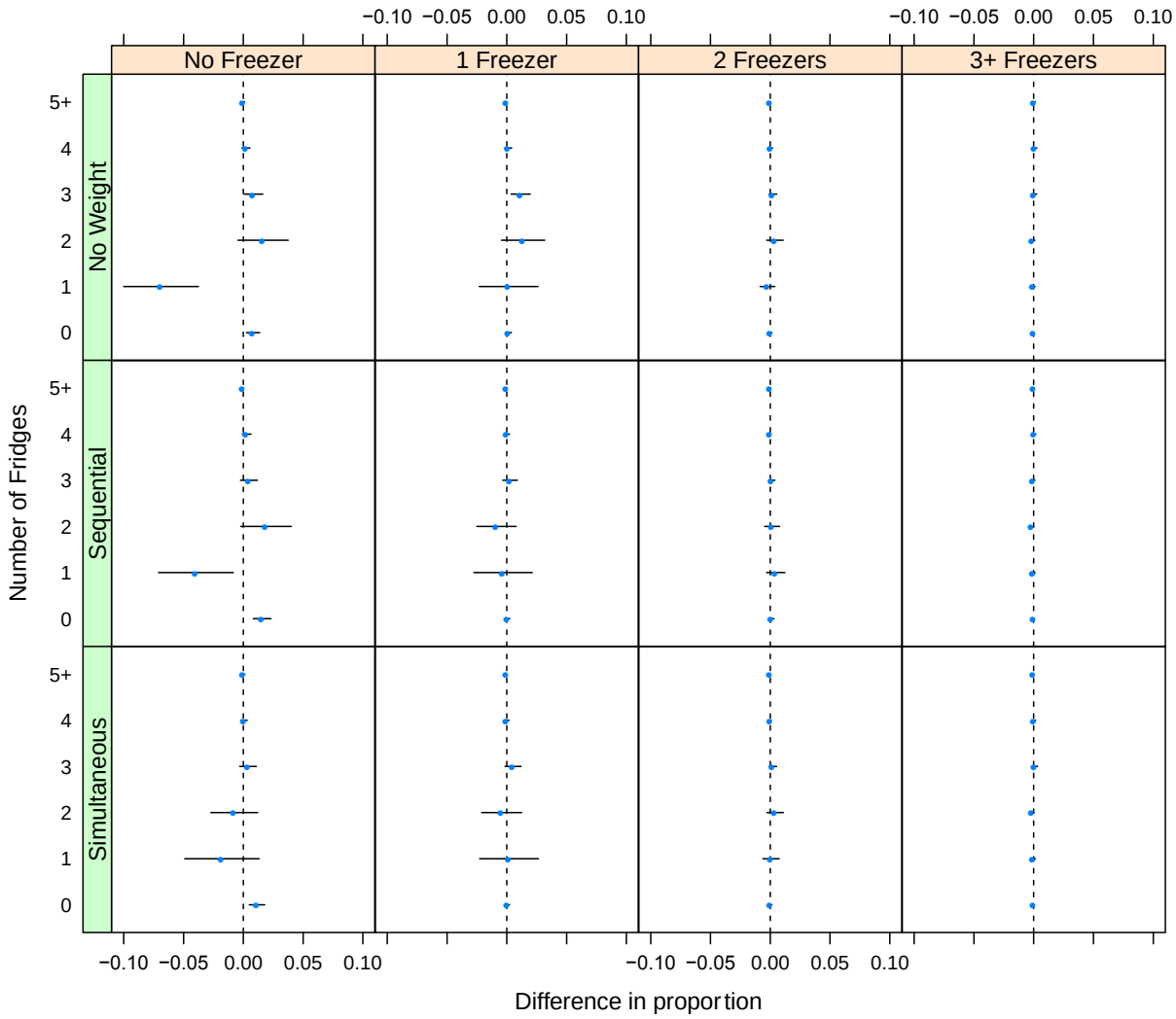

Figure 19. Differences in the proportions of numbers of refrigerators and freezers between AMT RP and RECS, showing unweighted data as well as the two weighting methods. Bonferroni-corrected confidence intervals are shown.

Here we find that both methods demonstrate improved agreement with RECS relative to unweighted data. The simultaneous method produces somewhat smaller differences, with the largest disagreement outside calculated confidence intervals being for homes with neither a refrigerator nor freezer (about 1% higher proportion than RECS). In all other combinations of refrigerators and freezers, differences for the simultaneous method lay within the confidence intervals. All differences for the simultaneous method were below the interpretive thresholds for both confidence intervals and effect size, and were therefore considered to be "minor."

4.4.2 Chi-squared tests

To confirm the observations we saw in the above plots, we calculated chi-squared values for the number of refrigerators, the number of freezers, and the numbers of refrigerators and freezers simultaneously; see Table 8. Tests for refrigerators resulted in the same (low)

p-value of less than 1E-5, well below the significance threshold, for all weighting methods. For freezers, the simultaneous method had the greatest *p*-value, (indicating better agreement with RECS) followed by the sequential method and then the unweighted data. For refrigerators and freezers together, the simultaneous method had the greatest *p*-value, and the *p*-value of the sequential method was slightly lower than that of the unweighted data. Consistent with our earlier observations, we found that the chi-squared results for the proportions of refrigerators alone, as well as for refrigerators and freezers together, indicated statistically-significant ($p \leq 0.05$) differences for both weighting methods. For freezers alone, the simultaneous method resulted in no statistically significant difference. However, two tests resulted in $p > 0.01$, which was still considered by our interpretive threshold to be a "minor" difference: the sequential method for freezers, and the simultaneous method for refrigerators and freezers together.

Table 8. Chi-squared results for the proportions of refrigerators and freezers

	***p*-value of Pearson's Chi-squared test (AMT versus RECS)**		
Quantity	**Unweighted data**	**Sequential weighting method**	**Simultaneous weighting method**
Proportions of refrigerators	< 1.00E-5*	< 1.00E-5*	< 1.00E-5*
Proportions of freezers	0.00495	0.0130	0.124
Proportions of refrigerators and freezers (simultaneously)**	0.00654	0.00627	0.0250

* Result of 10,000 Monte Carlo trials
** Considered only for homes with 0-2 freezers

4.4.3 Average numbers of refrigerators and freezers across demographics

We next examined how the average numbers of refrigerators and freezers per household varied across demographic variables. We found that they varied quite strongly, ranging from 1.09 to 1.53 for refrigerators, and from 0.13 to 0.53 for freezers, with population averages of 1.25 and 0.33 for refrigerators and freezers, respectively. In Figure 20 and Figure 21, we plot average numbers and confidence intervals versus demographic variables for RECS refrigerators and freezers, respectively. There are strong differences among various demographic groups. For refrigerators, there are differences for income, education and size of household. For freezers, the largest differences are for race, Hispanic origin, geographic region and size of household.

In Figure 22 and Figure 23, we plot differences between AMT RP and RECS for AMT data unweighted, and weighted using the two methods, for the average numbers of refrigerators and freezers, respectively.

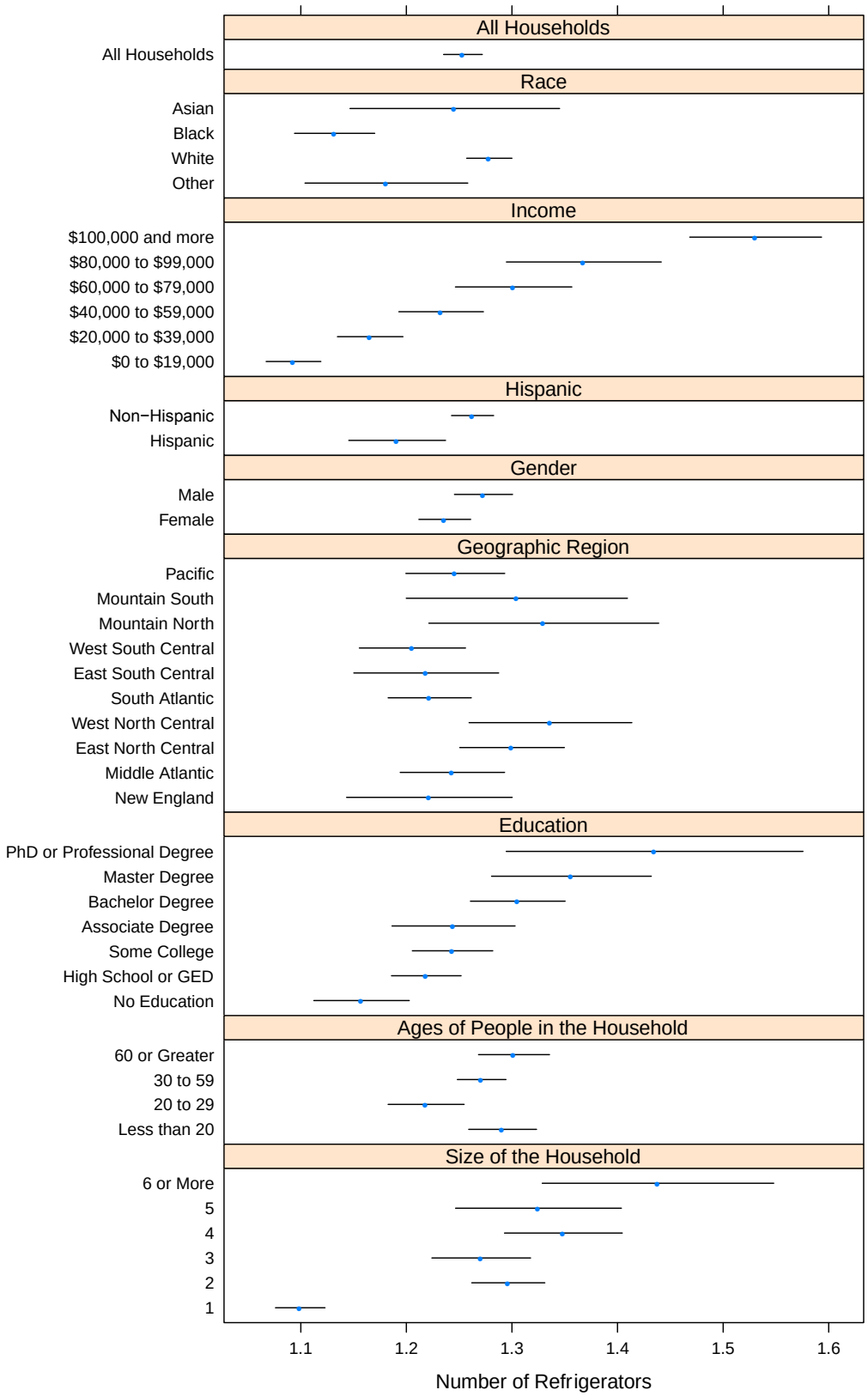

Figure 20. Average number of refrigerators versus demographic variable, with standard 95% confidence intervals.

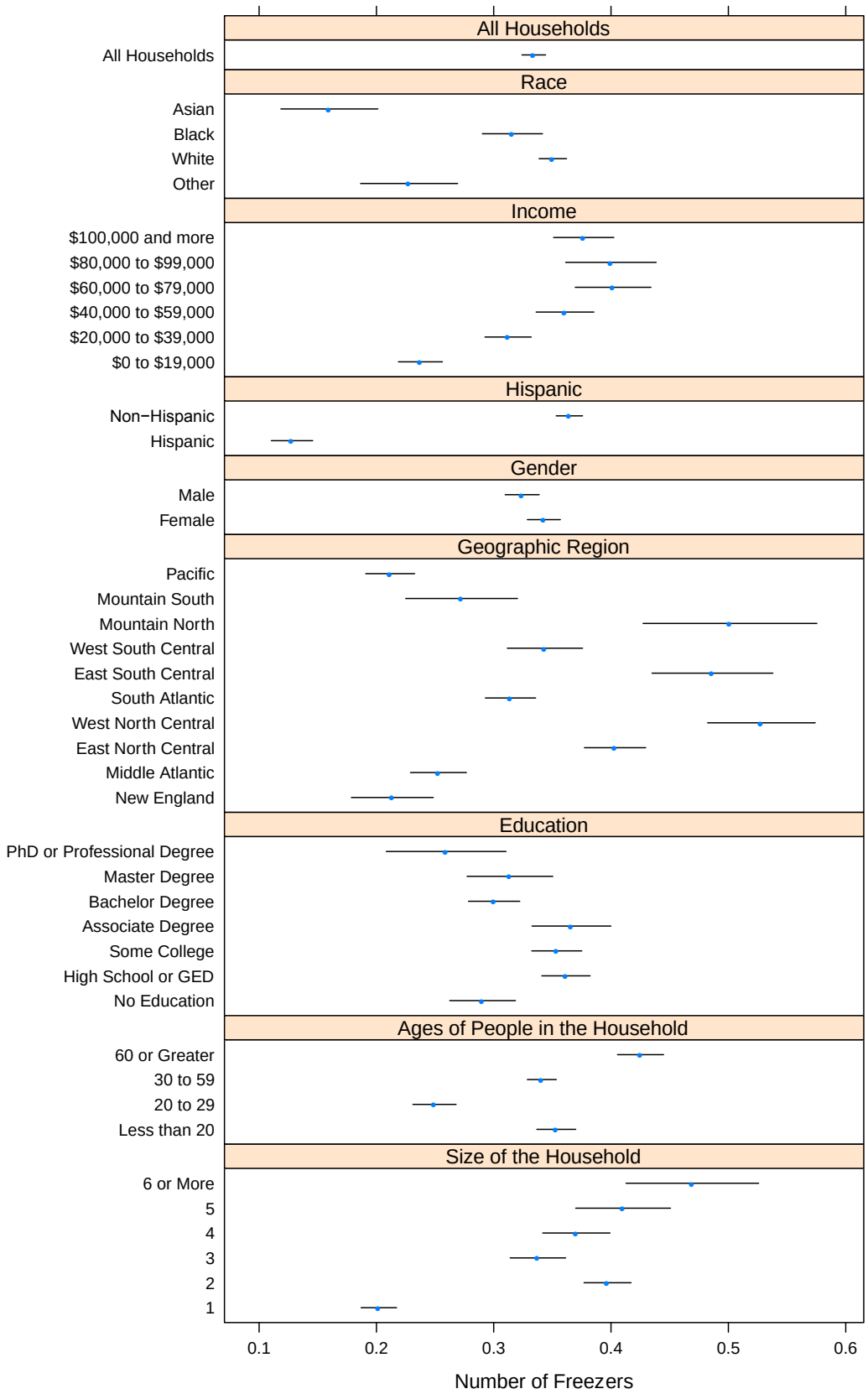

Figure 21. Average number of freezers versus demographic variable, with standard 95% confidence intervals.

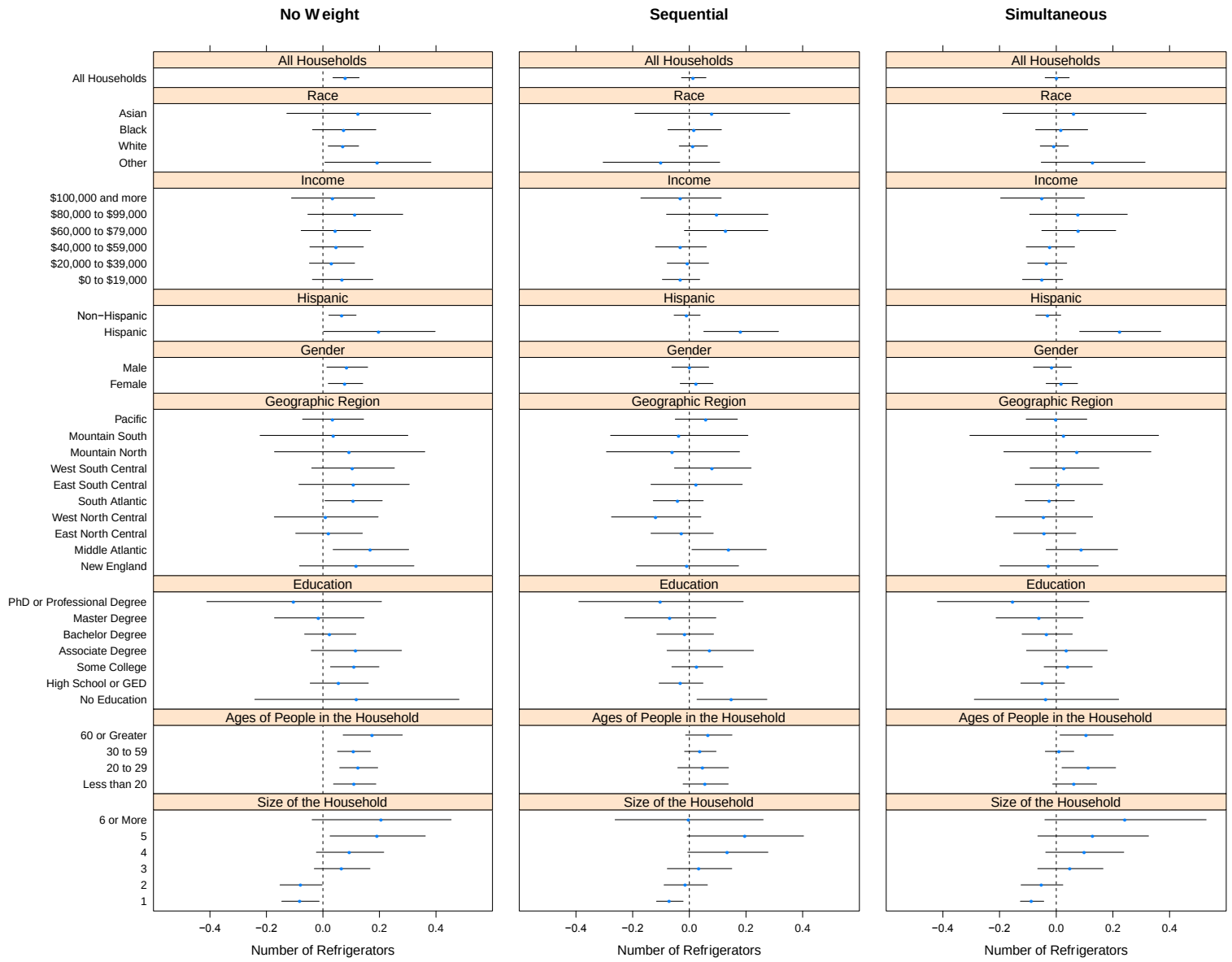

Figure 22. Differences between AMT RP and RECS in average number of refrigerators versus demographic variables, for unweighted data and the two weighting methods. Standard 95% confidence intervals are shown.

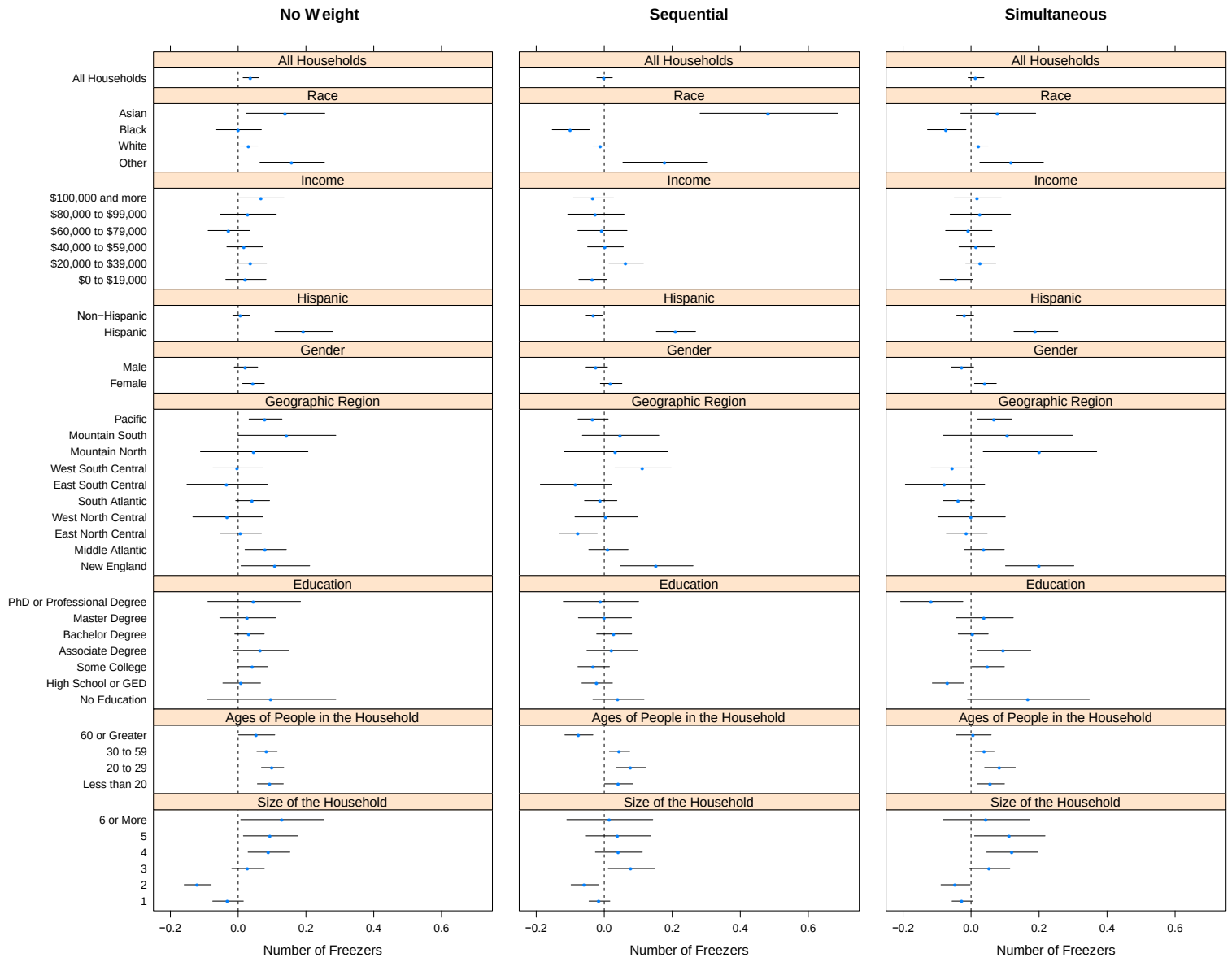

Figure 23. Differences between AMT RP and RECS in average number of freezers versus demographic variables, for unweighted data and the two weighting methods. Standard 95% confidence intervals are shown.

For refrigerators, both weighting methods result in better agreement with RECS than the unweighted data, but we see relatively little difference between the sequential and simultaneous methods (as judged by the numbers of variables where the confidence intervals of the differences overlap with zero). Notably, both weighting methods fail to provide agreement among Hispanic households. Both methods also leave a noticeable residual trend with respect to household size. These differences are considered to be "major" by the effect size interpretive threshold established in Section 3.6.4, but "minor" by the confidence interval threshold.

For freezers, neither weighting method results in better agreement with RECS than the unweighted data, and overall agreement with RECS is worse than for refrigerators. For the sequential method, the number of freezers in the Asian population differs from RECS by more than 0.4, whereas for the simultaneous method agreement is within the confidence intervals. However, for education, the sequential method produces agreement in every category, whereas the simultaneous method produces several categories that fall slightly outside the confidence intervals. Agreement between methods is greater for other demographic variables, with the biggest differences for both weighting methods among Hispanic households, non-white households, and some geographic regions. Most of these differences are considered to be "major" by the effect size threshold, but "minor" by the confidence interval threshold.

In an attempt to quantitatively assess which method gave the better agreement with RECS, we have also calculated the *z* values (defined in Section 3.6.1) for each demographic variable and tabulated the median, average and maximum values, along with the number of variables that fell outside the 95% confidence interval, in Table 9 and Table 10. We find that for refrigerators, both methods produce a significant improvement over the unweighted data (as judged by all but the maximum values). For freezers, differences are less pronounced, though the sequential method appears to produce better agreement with RECS (as judged by three of the five quantities shown in the Table), but visual inspection of the differences by demographic variable for the simultaneous method lie closer to zero than for the sequential method or unweighted data.

Table 9. Statistics in *z* values of differences between AMT and RECS average numbers of refrigerators across demographic variables.

	Median	Average	Maximum	Number outside 95% confidence interval
No weight	1.39	1.62	3.69	16
Sequential	0.78	0.95	2.87	4
Simultaneous	0.74	0.98	4.05	4

Table 10. Statistics in *z* values of differences between AMT and RECS average numbers of freezers across demographic variables.

	Median	Average	Maximum	Number outside 95% confidence interval	Number outside 99.7% confidence interval*
No weight	1.64	1.97	6.05	17	7
Sequential	1.24	1.64	7.15	15	5
Simultaneous	1.69	1.81	5.78	17	4

* Corresponds to $z = 3$

The conclusion of this analysis is that the two methods appear to be delivering similar results, with no clear advantage to one method over the other. The agreement with RECS across demographic variables is stronger for numbers of refrigerators than for numbers of freezers, indicating a larger sample bias in the population of freezer owners. However, even for freezers, the average *z* values are within the 95% confidence interval threshold ($z = 1.96$) for approximately 60% of the demographic variables examined, and within the 99.7% confidence interval ($z = 3$ or "3-sigma") for more than 80% of the demographic variables.

4.5 Evaluation of TS results

4.5.1 Proportions of numbers of TVs

In Figure 24, we present results for the number of TVs per household according to RECS. Differences between RECS and AMT, for AMT data unweighted, and weighted using the two methods, are shown in Figure 25.

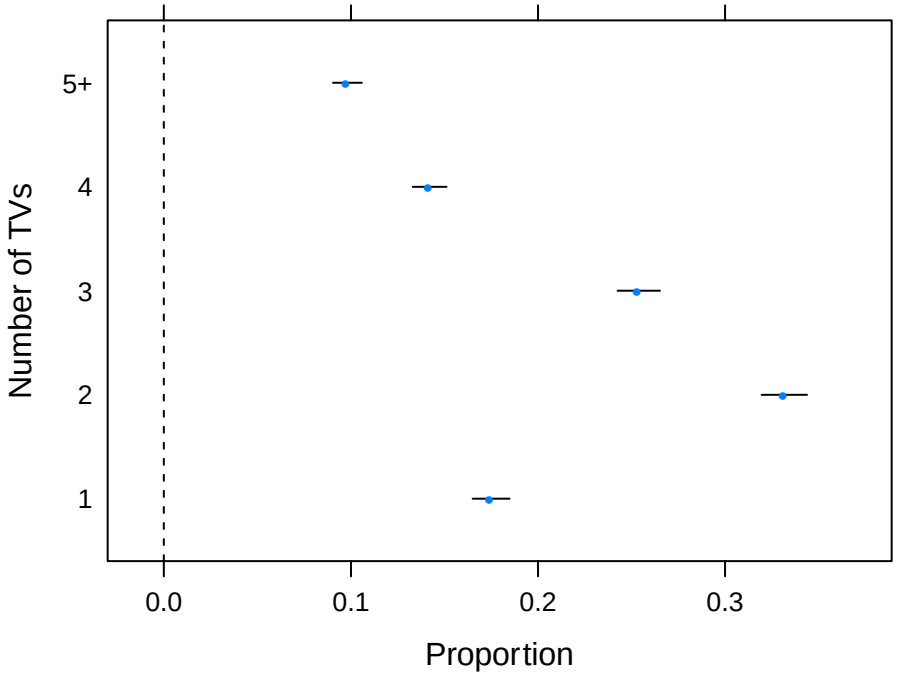

Figure 24. Proportions of the number of TVs in RECS, with Bonferroni-corrected confidence intervals

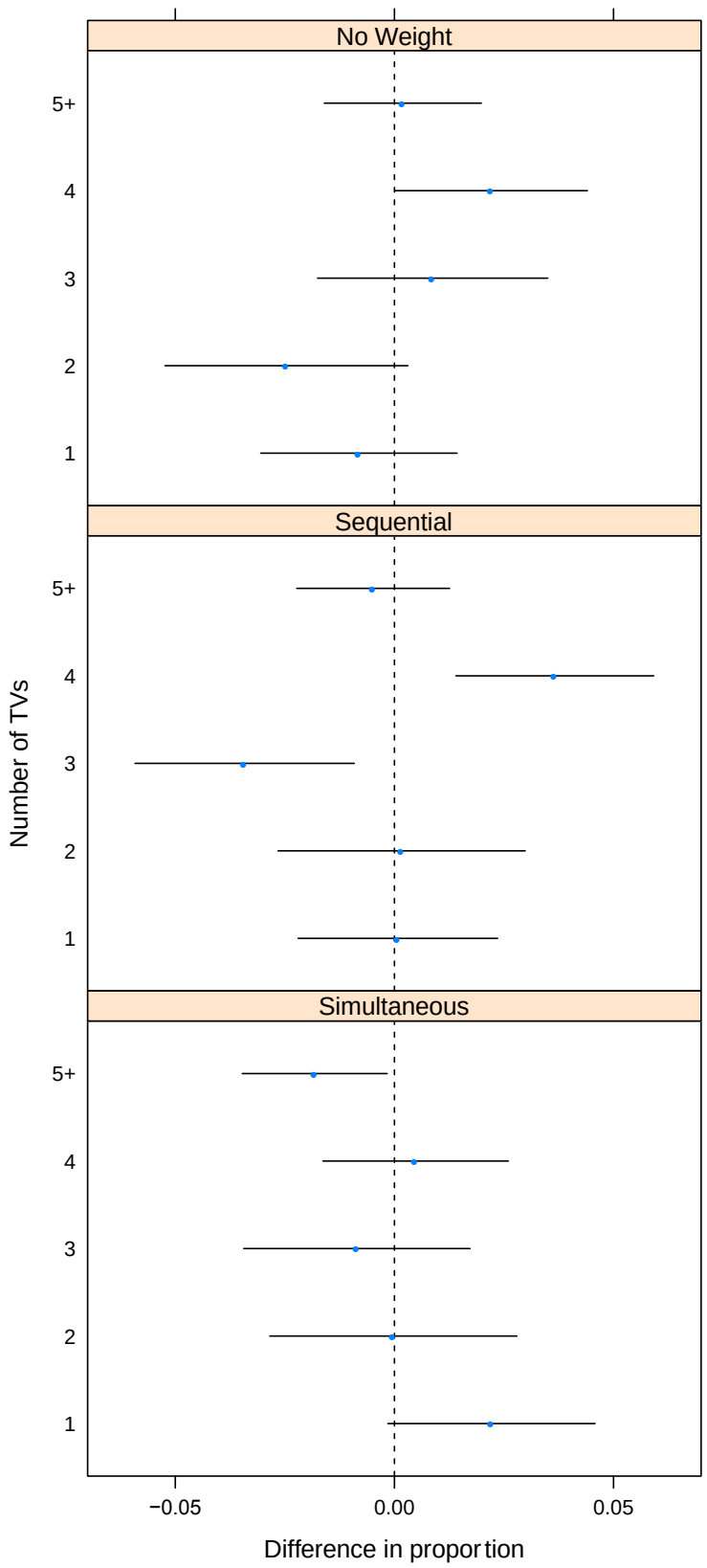

Figure 25. Differences in proportions of numbers of TVs between AMT and RECS. Shown are unweighted, sequential weighting and simultaneous weighting results with Bonferroni-corrected confidence intervals.

Both the unweighted data and the simultaneous method provide better agreement with RECS than the sequential method. All but one of the differences calculated with the unweighted data fall within the calculated confidence intervals, and the same is true for the simultaneous method. For the sequential method, agreement falls outside confidence intervals for two proportions (3 and 4 TVs) by an amount considered "major" by the effect size interpretive threshold, but "minor" by the confidence interval threshold.

4.5.2 Chi-squared test

Results from Pearson's chi-squared test were consistent with this conclusion—the *p*-values for the unweighted data and the simultaneous method were much greater than the *p*-value for the sequential method. However, while all methods resulted in a rejection of the null hypothesis ($p \leq 0.05$), confirming that the AMT and RECS proportions are not identically distributed, the tests for unweighted data and the simultaneous weighting method resulted in $p > 0.01$, which by our interpretive threshold was considered to be a "minor" difference.

Table 11. Chi-squared results for proportions of TVs

	***p*-value of Pearson's chi-squared test (AMT versus RECS)**		
Quantity	**Unweighted data**	**Sequential weighting method**	**Simultaneous weighting method**
Proportions of TVs	0.0271	3.31E-5	0.0149

4.5.3 Proportions of numbers of STBs

The proportions of numbers of STBs in RECS are shown in Figure 26, and differences in proportions between AMT and RECS for AMT data unweighted, and weighted using the two methods, are shown in Figure 27. The agreement is poor regardless of the weighting method used, with about 14% more one-unit homes and 15% fewer three-unit homes in AMT than in RECS. These differences are also considered to be "major" by our interpretive thresholds.

These differences could be due to a sampling bias, but we think it is more likely that they are due to a change in the distribution of STBs between 2009 (the year for which RECS were collected) and 2012 (the year that the AMT data were collected). The pay-TV industry and the associated STBs are rapidly evolving. The late 2000s saw a surge in flat-panel TV sales and an increase in pay-TV subscription and STB/digital video recorder (DVR) use. For example, data from The Nielsen Company indicate that the percentage of TVs with a STB attached has increased from 52% in March 2009 to 77% in April 2012 (Nielsen, 2012). We feel that the change in the industry is the most likely explanation for the observed differences in STB proportions between AMT and RECS.

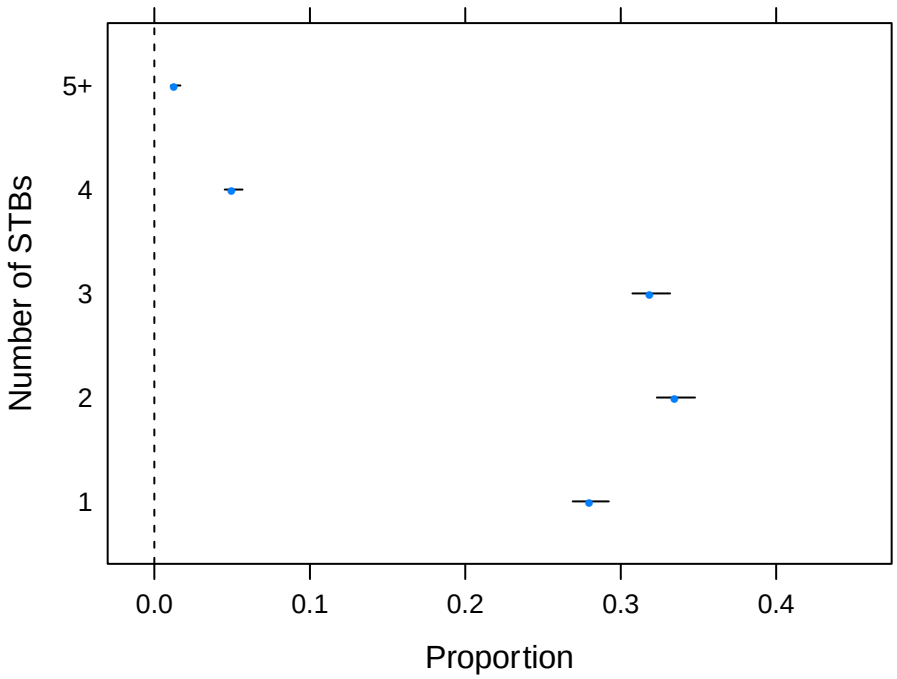

Figure 26. Proportions of the number of STBs in RECS, with Bonferroni-corrected confidence intervals.

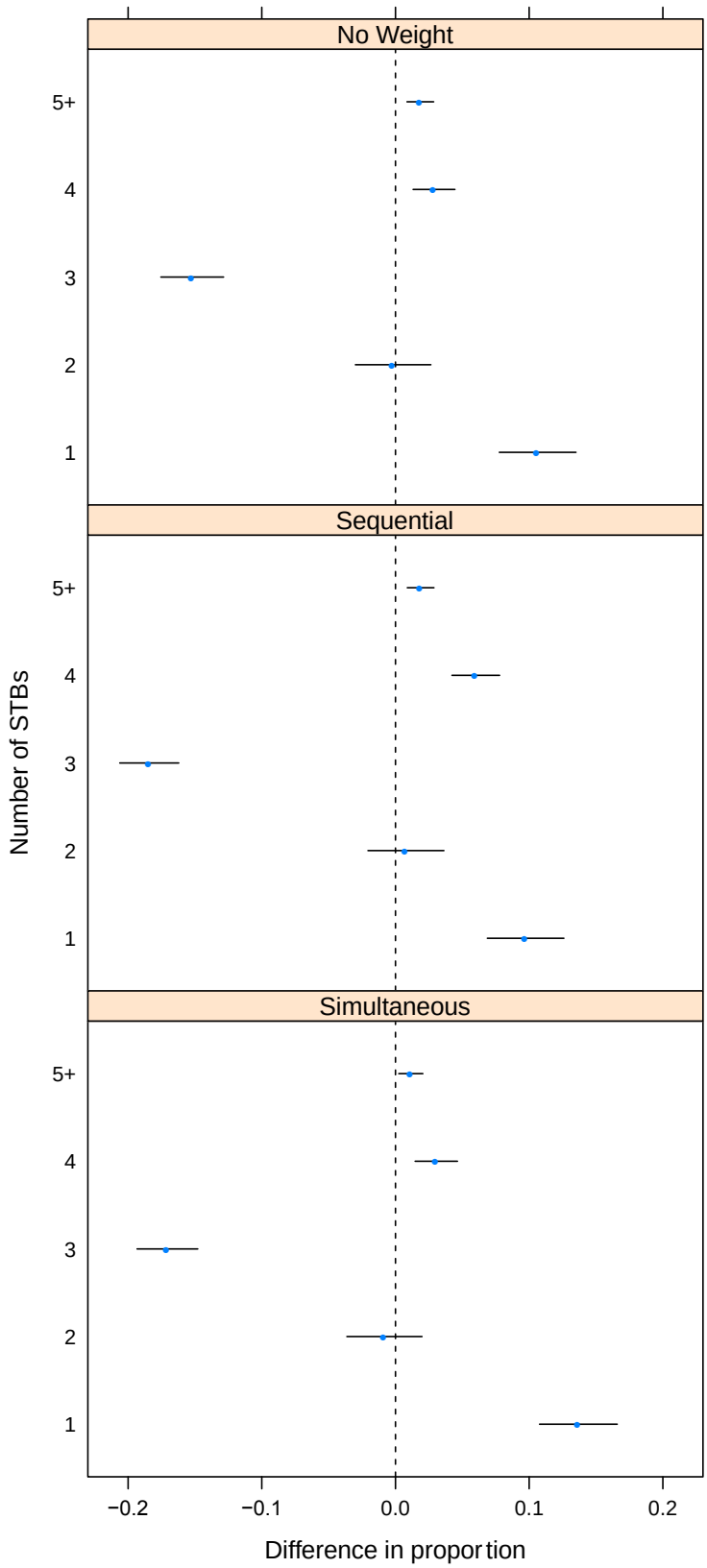

Figure 27. Differences in proportions of numbers of STBs between AMT and RECS. Shown are unweighted, sequential weighting and simultaneous weighting results with Bonferroni-corrected confidence intervals.

4.5.4 Average numbers of TVs across demographics

We examined the average number of TVs per household across demographic variables. Figure 28 shows the average number of TVs in RECS by demographic variable. The numbers varied, though not quite as strongly as for refrigerators and freezers, ranging from 1.94 to 3.55. One can see differences within several demographic groups, in particular income and size of household.

Figure 29 shows differences from RECS for AMT data unweighted, and weighted using the two methods. There is little difference between the results from unweighted data, the simultaneous method, and the sequential method. All three sets of data agree well with RECS, and there are only a small number of demographic variables for which the differences fall outside of the confidence intervals. The few demographic variables falling outside confidence intervals for either weighting method were considered to be "major" by the effect size interpretive threshold, but "minor" by the confidence interval threshold.

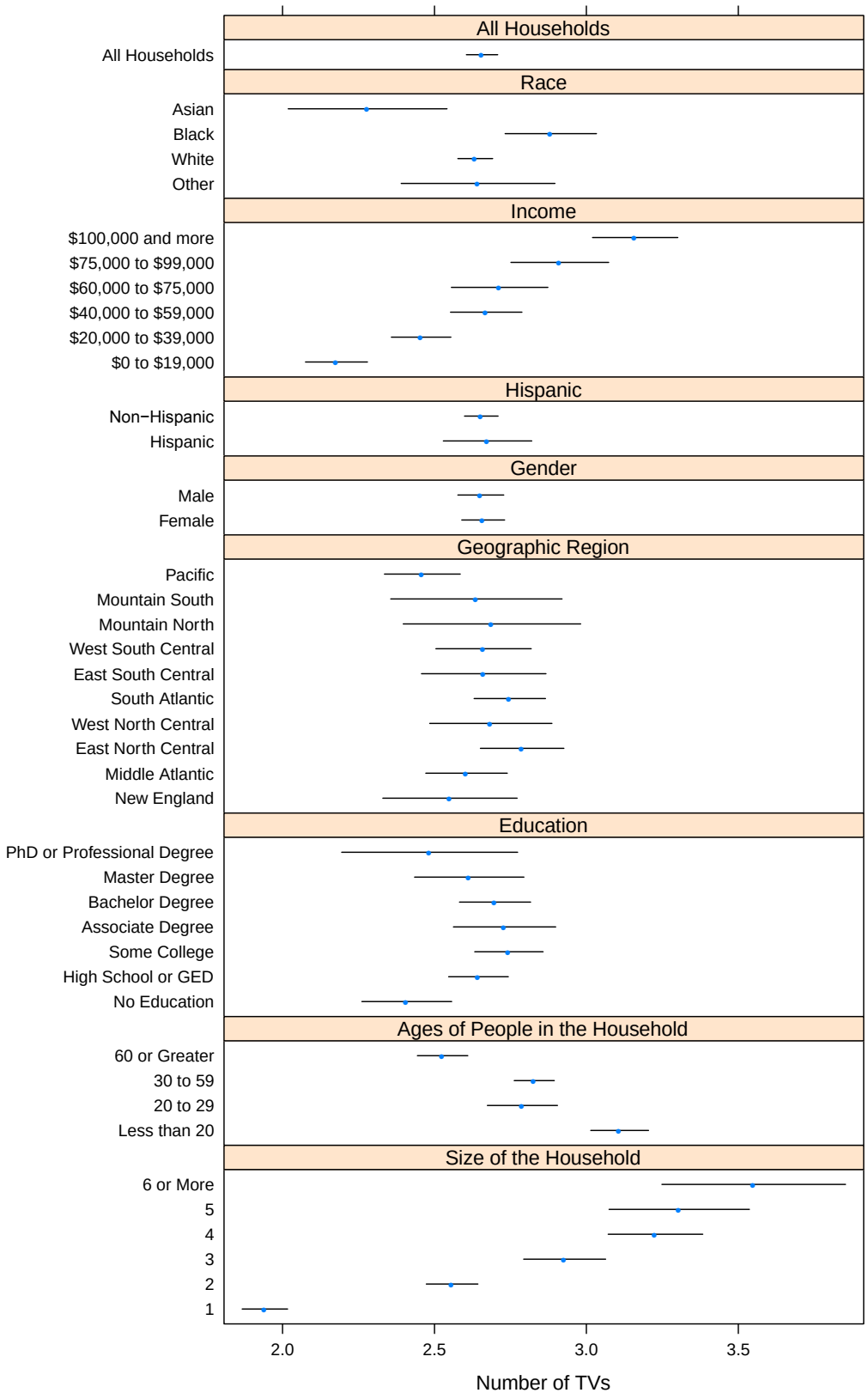

Figure 28. Average number of TVs versus demographic variable, with standard 95% confidence intervals.

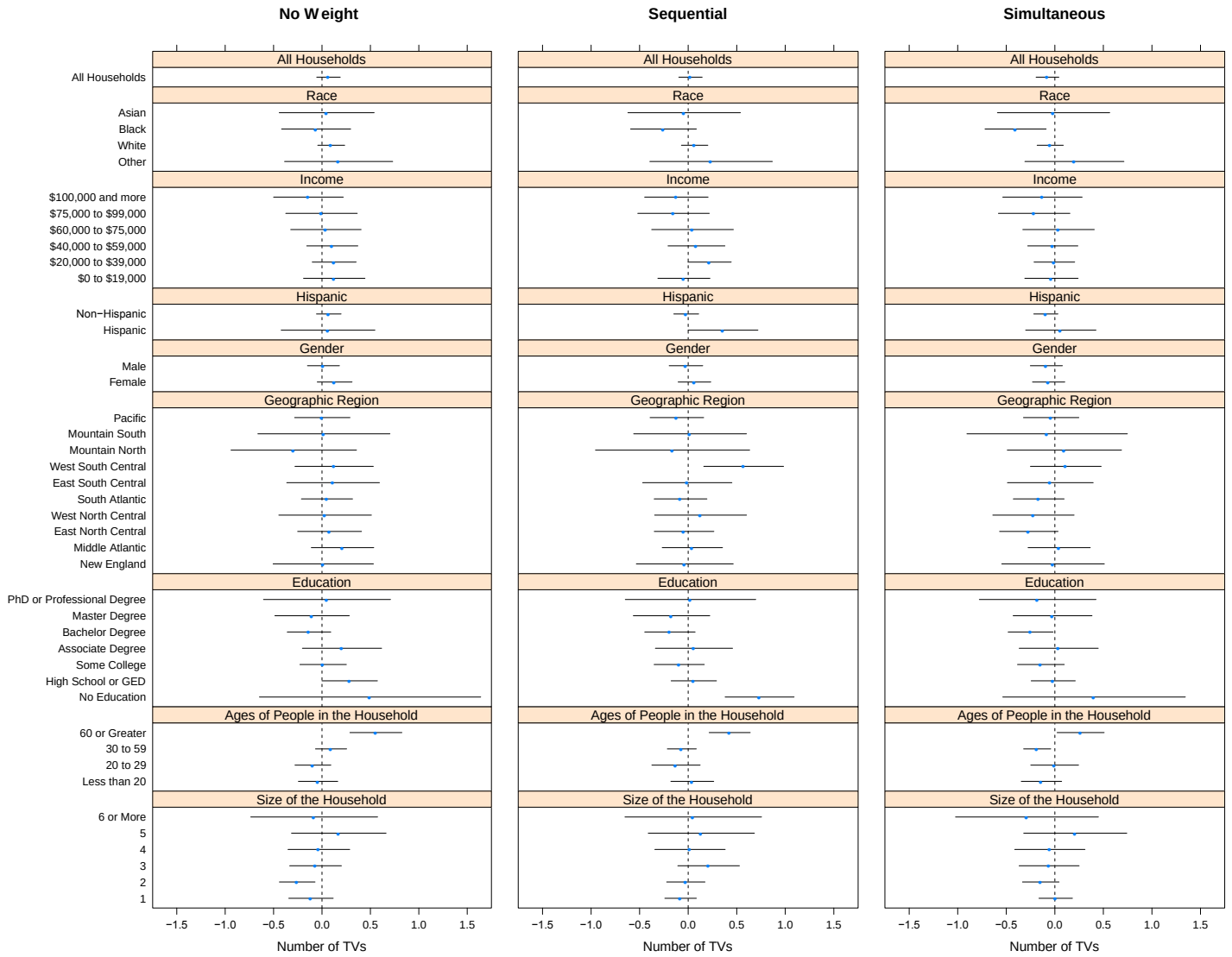

Figure 29. Differences between AMT RP and RECS in average number of TVs versus demographic variables, for unweighted data and the two weighting methods, with standard 95% confidence intervals.

We calculated the *z* values for each demographic variable and tabulated the median, average and maximum values in Table 12 along with the number of variables that fell outside the confidence intervals. Differences among the methods (as judged by all but the maximum values) are not very pronounced; there does seem to be a mild improvement in the maximum value with the simultaneous method over either the unweighted or sequential method.

Table 12. Statistics in *z* values of differences between AMT and RECS average numbers of TVs across demographic variables.

	Median	Average	Maximum	Number outside 95% confidence interval
No weight	0.60	0.76	4.06	2
Sequential	0.55	0.82	4.06	3
Simultaneous	0.61	0.77	2.55	4

4.5.5 Proportions of primary service providers

We examined the proportion of primary service providers. Figure 30 shows the proportion of service providers from IMS Research and NCTA (see Section 3.1.3 for details). Figure 31 shows differences between AMT and the IMS Research/NCTA data, for AMT data unweighted, and weighted using the two methods.

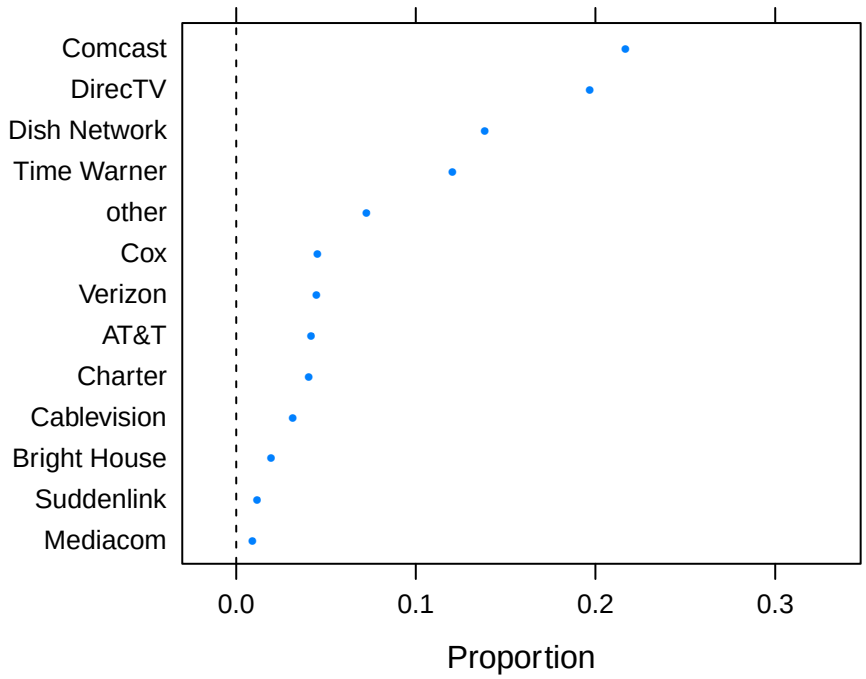

Figure 30. Primary service providers from IMS Research and NCTA. Error bars are not visible, because the total number of subscribers is large and the resulting confidence intervals of proportions are small.

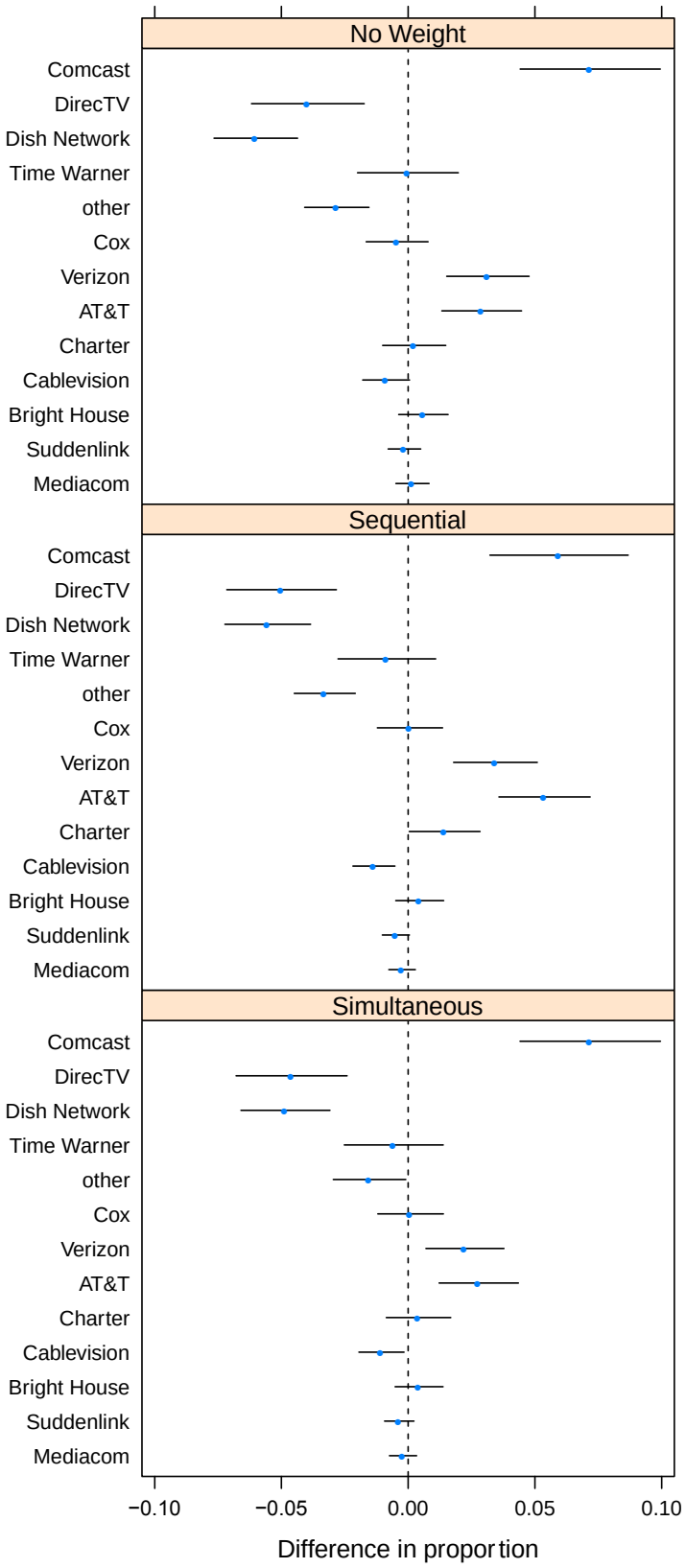

Figure 31. Differences in primary service provider between AMT and IMS Research/NCTA, with Bonferroni-corrected 95% confidence intervals.

The unweighted AMT data indicate some clear major differences from the reference data that are not corrected by either weighting method. The main differences are greater proportions in three services providers (Comcast, Verizon and AT&T) and smaller proportions in two other providers (DirecTV and Dish Network). A likely explanation is that the three service providers with greater proportions also provide internet service, while the two with smaller proportions are satellite providers. Because AMT participants are very likely to also have internet service at home, it is reasonable to expect that they would be biased toward STB companies that provide high-quality internet service in addition to TV programming.

5 Discussion

As stated in the Introduction, we set out to answer three questions about online surveys (specifically those obtained using AMT). We repeat the questions here and address answer each in turn.

1. Are unweighted results from online surveys consistent with those obtained with more traditional surveys? If not, are online survey results more nationally representative after applying post-stratification weighting?

We showed in Sections 3.2.4 and 4.3 how the demographic distributions of unweighted AMT data differ markedly from RECS (a traditional survey considered to be representative of the U.S. population). However, by applying either of two post-stratification weighting methods, we were able to make AMT results more consistent with RECS demographics.

To answer the question of whether survey *results* (and not just their demographic distributions) are consistent with those of traditional surveys, and whether they are improved by post-stratification weighting, we performed a number of statistical tests, described in Sections 4.4 through 4.5 and summarized in Table 13. For each test, we ranked the performance of each method (including unweighted data) relative to the other methods, based either on the mean absolute differences from reference data (for differences of proportions and differences in average numbers) or the chi-squared test numerical results themselves. We also qualitatively evaluated the overall performance of the highest and lowest-ranked method for each test, based on criteria defined in the Table.

Table 13. Statistical tests performed on AMT data to compare weighting methods.

		Rank by Method*			Performance by Method**		
Test	**Parameter**	**Un-weighted**	**Sequen-tial**	**Simul-taneous**	**Un-weighted**	**Sequen-tial**	**Simul-taneous**
Differences in proportions	Refrigerators	3	2	1	Poor	Fair	Good
	Freezers	3	1	1	Fair	Excellent	Excellent
	Refrigerators and freezers	3	2	1	Fair	Fair	Good
	TVs	2	3	1	Excellent	Fair	Excellent
	STBs	1	1	1	Bad	Bad	Bad
	Primary service provider	2	2	1	Poor	Poor	Poor
Chi-squared distributions of proportions	Refrigerators	1	1	1	Poor	Poor	Poor
	Freezers	3	2	1	Poor	Fair	Good
	Refrigerators and freezers	2	3	1	Poor	Poor	Fair
	TVs	1	3	2	Fair	Poor	Fair
Differences in average number by demographics	Refrigerators	3	1	1	Fair	Fair	Fair
	Freezers	3	1	2	Fair	Fair	Fair
	TVs	1	3	1	Good	Good	Good
AVERAGE RANK		2.2	1.9	1.2			

* Ranks are based on the numerical criteria defined in text. 1 = best, 2 = middle, 3 = worst. For methods with similar results, both methods are given the highest unallocated rank.

** Definitions:

Excellent: Differences in all categories are within statistical uncertainty

Good: Differences in all categories are very nearly within statistical uncertainty ("minor" confidence interval and effect size interpretive thresholds)

Fair: Agreement in a large number of categories, with a few moderate outliers falling outside statistical uncertainty ("minor" confidence interval interpretive threshold)

Poor: Disagreement in several categories falling outside statistical uncertainty ("major" confidence interval interpretive threshold)

Bad: Disagreement in multiple categories falling far outside statistical uncertainty

For chi-squared results, Good is ≥ 0.05, Fair is ≥ 0.01 and Poor is < 0.01

In six of the 13 tests, unweighted AMT data did not agree well with traditional data (rating of "Poor" or "Bad"). In three of those six cases, one or both weighting methods improved the agreement of AMT results, sometimes markedly. For the seven tests where unweighted AMT data received a rating of "Fair" through "Excellent," weighting improved the rating in two of the tests. However, the overall differences between the unweighted AMT and reference data were still quite small; the mean absolute difference in proportions for all parameters was 2.3%, and STBs was the only parameter with a mean absolute difference greater than 3%. Therefore, while larger differences existed for some responses, the unweighted data was generally close to the reference data before weighting.

2. Does post-stratification weighting sufficiently correct for demographic differences between online surveys and more traditional surveys?

For differences of proportions, refrigerators, freezers and TVs all had "Good" or "Excellent" performance for at least one weighting method. The chi-squared tests, however, were more sensitive, scoring "Fair" to "Good" (and for refrigerators, "Poor") for the highest-ranked weighting method, with all but one test possessing a *p*-value below 0.05 (the exception was the simultaneous weighting method for freezers).

When comparing average numbers of refrigerators, freezers and TVs for various demographic subgroups, differences in weighted results were rated as "Fair" to "Good," but there was little detectable improvement over unweighted data with the exception of refrigerators (and by the performance criteria, all three methods still received a rating of "Fair"). For refrigerators and TVs, we found that the average numbers fell within the 95% confidence intervals of our reference data for approximately 90% of demographic variables. For freezers, only about 60% of the 41 demographic variables examined fell within the 95% confidence intervals, for both weighted and unweighted data, but more than 80% of demographic variables fell within the 99.7% (3-sigma) confidence intervals.

Overall, it appears that there may be some small biases in our sample for measurements of refrigerators, freezers and TVs. Many of these differences, while falling outside the calculated confidence intervals, were considered "minor" by our interpretive thresholds. Among those considered "minor" were differences in proportions of refrigerators, proportions of refrigerators and freezers, and the chi-squared tests for refrigerators and freezers, and TVs. Differences considered "major" by the effect size threshold, but "minor" by the confidence interval threshold were differences in average numbers of freezer among some demographic subgroups. The only difference considered to be unequivocably "major" was the chi-squared test for refrigerators, which stands in contrast to our qualitative conclusions above.

We observed larger differences in proportions for STBs and primary service providers. These differences remained, regardless of the weighting method used. The number of STBs was found to differ substantially, likely due to the fast-changing nature of the STB market and length of time—about 3 years—between when the reference and AMT surveys were conducted. For primary service providers, there were some differences in the underlying populations despite the data being collected in the same year: we found that the AMT data

contained more respondents who subscribed to Comcast, Verizon and AT&T, three cable service providers who also provide internet service, than in the reference data. This mismatch appears to reflect real differences in the sample populations that were undoubtedly considered "major." However, given the many other ways in which the AMT results agree closely with the reference data, we argue that even these differences are probably not important in most cases. In addition, questions could be added to future surveys to ensure that this or other biases are quantified, and, if necessary, corrected by adjusting the weights of these particular populations to match a target distribution. One could also opt to switch to more traditional sampling methods, such as random-digit dialing, but such a methodology may be much more expensive.

3. Which post-stratification weighting method performs best in correcting demographic distributions from online surveys?

The simultaneous weighting method ranked equal to or higher than the sequential method in almost every test we considered, with an average rank of 1.2 versus 1.9 for the sequential method. Its performance was also judged to be "Good" or "Excellent" for six of the 13 tests. For the remaining seven tests, the simultaneous method was ranked higher than the sequential method in three of the tests (in three other tests, there was no appreciable difference between the methods, and in one test, the sequential method was ranked higher). In the Pearson's chi-squared test for TVs, the unweighted data was preferable to either weighting method (though performances of both unweighted data and the simultaneous method were both ranked "Fair"). Overall, it appears that the simultaneous method is superior to the sequential method.

We believe the simultaneous method performs better than the sequential method because it is able to correct for correlations among variables. Although the sequential method utilizes more demographic variables than the simultaneous method, the sequential method matches demographics in only one-dimensional "slices." The simultaneous method, however, matches demographics to the reference distributions in multiple dimensions at once. This capability appears to confer a statistical advantage as a result.

There are situations, however, for which the simultaneous method is impractical, for instance, when the reference demographic sample is smaller than the AMT survey sample, or when the number of samples in the reference is small (less than approximately 1000). The simultaneous method does not work very well in these situations, because it relies on having a sufficient number of samples to allow for simultaneous matching of several demographic variables. The sequential method will still work in this situation, because it requires fewer samples to match single dimensions of the demographic distributions. Therefore, the use of the sequential method, while not as good as the simultaneous method, would still be preferable to leaving the data unweighted.

There is room for improvement in post-stratification weighting that could give rise to even better methods. One idea is to combine the two methods. The simultaneous method is not currently able to weight all demographic variables at once, so the sequential method could be used to correct the demographic variables that were left unweighted by the

simultaneous method. This or other potential improvements can now be sensitively and objectively evaluated through the battery of tests we have developed. Given the different conclusions drawn by some of the tests, additional tests could also be developed to further identify differences in weighting methods or the underlying data.

6 Conclusions

We have shown that AMT can be used to collect data with a wide range of U.S. population demographics, and weighted to closely reflect those demographics using either of two post-stratification weighting methods ("sequential" and "simultaneous"). We examined the results of two surveys, one on refrigeration products (RP) and another on TVs and STBs (TS), focusing on five key household questions for which representative U.S. data were available for comparison: numbers of refrigerators, numbers of freezers, numbers of TVs, numbers of STBs and primary service provider. For each question, we applied one or more of the following statistical tests to evaluate how closely the AMT data—unweighted, and weighted by the two methods—matched the reference data: differences in proportions, distributions of proportions (using Pearson's chi-squared test), and differences in average numbers of devices across demographic variables.

The results indicated that the use of either method improved the agreement between AMT and reference data, sometimes greatly, in approximately half of the comparisons. Moreover, we found that the simultaneous weighting method is usually superior to the sequential method, and is therefore the recommended weighting method for general use. However, in cases where the simultaneous method is not suitable (e.g., if the number of reference samples is below approximately 1000), the sequential method could still be used to improve the agreement over unweighted data. Opportunities exist to improve the weighting methods, as well as the statistical tests used to evaluate them.

Some differences in sample populations appear to exist between the AMT and reference data we examined. We generally considered the differences for refrigerators, freezers and TVs to be minor, and the differences for STBs and primary service providers to be major. For the STBs, large changes in the STB market since the time the RECS data, used as our reference, was collected in 2009 appear to invalidate using RECS to make a direct comparison to the AMT data. For primary service providers, there do appear to be some biases in the sample, with the possible explanation that AMT users tend to subscribe to service providers who also provide home internet service. Depending on the intended purpose of data collected using AMT, such biases may or may not be important, but in cases where they are, additional questions and/or further post-survey adjustments could be made to correct for them. If such biases are determined to be unacceptable, researchers might be better served by more traditional sampling methods in these cases.

7 Acknowledgments

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9 Appendices

9.1 Demographic comparison

Table 14. Demographics from unweighted AMT RP survey data and RECS.

	Unweighted AMT RP (General population)	Weighted RECS (General population)
Number of responses	2,145	12,083
Race		
• White	84.8%	78.9%
• Black	4.4%	13.5%
• Asian	4.4%	3.4%
• Other	6.4%	4.2%
Hispanic origin		
• Yes	5.9%	12.9%
• No	94.1%	87.1%
Annual household income		
• $0-19k	12.2%	20.9%
• $20-39k	23.1%	24.2%
• $40-59k	22.2%	18.6%
• $60-79k	15.5%	12.5%
• $80-99k	10.2%	8.2%
• $100k+	16.6%	15.6%
Education		
• No college	10.9%	38.3%

• Some college, no degree	34.4%	22.3%
• Associate degree	9.4%	9.5%
• Bachelor's degree	32.4%	19.4%
• Master's degree	10.0%	7.7%
• Professional/Doctorate degree	2.9%	2.3%
Homes with occupants of ages		
• 0-19	24.1%	22.8%
• 20-29	31.7%	14.4%
• 30-59	37.1%	41.5%
• 60+	7.2%	21.3%
Number of occupants		
• 1	10.5%	27.5%
• 2	30.7%	31.5%
• 3	23.9%	15.9%
• 4	19.5%	13.8%
• 5	10.3%	6.8%
• 6+	5.1%	4.3%
Census Division		
• New England	5.6%	4.9%
• Mid-Atlantic	13.0%	13.4%
• East North Central	15.7%	15.7%
• West North Central	7.7%	7.1%
• South Atlantic	19.8%	19.6%
• East South Central	5.0%	6.2%
• West South Central	9.4%	11.2%
• Mountain North	3.9%	3.5%
• Mountain South	2.9%	3.5%
• Pacific	16.9%	14.9%

Notes: Highlighted rows indicate demographics where AMT populations are half or lower than RECS. The proportions shown for each demographic variable excluded those households that answered "Don't know," "Decline to state" or left the answer blank.

Table 15. Demographic distributions in unweighted AMT RP and RECS general population data.

	Unweighted AMT RP (General population plus subgroups)	**Weighted RECS (General population)**
Number of responses	3,021	12,083
Race		
• White	76.1%	78.9%
• Black	11.0%	13.5%
• Asian	3.7%	3.4%
• Other	7.4%	4.2%

Hispanic origin		
• Yes	6.0%	12.9%
• No	94.0%	87.1%
Annual household income		
• $0-19k	11.2%	20.9%
• $20-39k	22.3%	24.2%
• $40-59k	20.9%	18.6%
• $60-79k	14.8%	12.5%
• $80-99k	9.5%	8.2%
• $100k+	15.2%	15.6%
Education		
• No college	18.5%	38.3%
• Some college, no degree	32.0%	22.3%
• Associate degree	8.9%	9.5%
• Bachelor's degree	28.3%	19.4%
• Master's degree	9.0%	7.7%
• Professional/Doctorate degree	2.5%	2.3%
Homes with occupants of ages		
• 0-19	23.4%	22.8%
• 20-29	29.4%	14.4%
• 30-59	34.8%	41.5%
• 60+	12.5%	21.3%
Number of occupants		
• 1	10.0%	27.5%
• 2	28.1%	31.5%
• 3	23.7%	15.9%
• 4	20.1%	13.8%
• 5	11.5%	6.8%
• 6+	6.5%	4.3%

9.2 Results tables

9.2.1 RECS

Table 16 through Table 19: Number of samples is 12,083
Table 18 and Table 20: Number of samples is 9,951.

Table 16. Proportions of numbers of refrigerators

Value	Proportion	Standard error	Lower CI	Upper CI
0	0.17%	0.04%	0.07%	0.27%
1	76.91%	0.38%	75.90%	77.92%
2	20.75%	0.37%	19.78%	21.72%

3	1.84%	0.12%	1.51%	2.16%
4	0.24%	0.04%	0.12%	0.36%
5+	0.10%	0.03%	0.02%	0.17%

Table 17. Proportions of numbers of freezers

Value	Proportion	Standard error	Lower CI	Upper CI
0	69.55%	0.42%	68.45%	70.66%
1	27.89%	0.41%	26.81%	28.96%
2	2.16%	0.13%	1.81%	2.51%
3	0.40%	0.06%	0.25%	0.55%

Table 18. Proportion of numbers of refrigerators and freezers in RECS

Number of refrigerators	Number of freezers				
	0	1	2	3+	total
0	0.15%	0.01%	0.00%	0.00%	0.17%
1	56.74%	18.89%	1.16%	0.12%	76.91%
2	11.58%	8.11%	0.90%	0.16%	20.75%
3	0.93%	0.73%	0.07%	0.10%	1.84%
4	0.11%	0.11%	0.02%	0.00%	0.24%
5	0.03%	0.03%	0.01%	0.00%	0.07%
6	0.00%	0.00%	0.00%	0.01%	0.01%
7+	0.02%	0.00%	0.00%	0.00%	0.02%
total	69.55%	27.89%	2.16%	0.40%	100.00%

Table 19. Proportions of numbers of TVs in RECS

Value	Proportion	Standard error	Lower CI	Upper CI
1	17.48%	0.38%	16.50%	18.46%
2	33.16%	0.47%	31.94%	34.38%
3	25.38%	0.44%	24.26%	26.50%
4	14.19%	0.35%	13.29%	15.09%
5+	9.79%	0.30%	9.02%	10.56%

Table 20. Proportions of the number of STBs in RECS

Value	Proportion	Standard error	Lower CI	Upper CI
1	28.06%	0.45%	29.22%	26.90%
2	33.55%	0.47%	34.77%	32.33%
3	31.96%	0.47%	33.16%	30.75%

4	5.08%	0.22%	5.64%	4.51%
5+	1.35%	0.12%	1.65%	1.05%

Table 21. Average numbers of refrigerators, overall and by demographic variable

Demographic category	Value	Average number	Standard error	Lower 95% CI	Upper 95% CI
All Households	N/A	1.2536	0.0094	1.2352	1.2719
Race	Other	1.1811	0.0393	1.1040	1.2582
Race	White	1.2786	0.0109	1.2572	1.3000
Race	Black	1.1321	0.0194	1.0941	1.1701
Race	Asian	1.2459	0.0506	1.1466	1.3451
Income	$0 to $19,000	1.0931	0.0132	1.0673	1.1190
Income	$20,000 to $39,000	1.1657	0.0158	1.1347	1.1968
Income	$40,000 to $59,000	1.2330	0.0204	1.1929	1.2730
Income	$60,000 to $79,000	1.3016	0.0281	1.2465	1.3568
Income	$80,000 to $99,000	1.3681	0.0374	1.2947	1.4414
Income	$100,000 and more	1.5308	0.0318	1.4684	1.5932
Hispanic	Hispanic	1.1913	0.0234	1.1454	1.2372
Hispanic	Non-Hispanic	1.2627	0.0102	1.2428	1.2827
Gender	Female	1.2364	0.0125	1.2119	1.2609
Gender	Male	1.2731	0.0141	1.2455	1.3006
Geographic Region	New England	1.2219	0.0400	1.1434	1.3003
Geographic Region	Middle Atlantic	1.2436	0.0252	1.1942	1.2931
Geographic Region	East North Central	1.3001	0.0253	1.2505	1.3496
Geographic Region	West North Central	1.3365	0.0393	1.2594	1.4136
Geographic Region	South Atlantic	1.2221	0.0201	1.1827	1.2616
Geographic Region	East South Central	1.2188	0.0350	1.1502	1.2874
Geographic Region	West South Central	1.2058	0.0257	1.1555	1.2561
Geographic Region	Mountain North	1.3302	0.0555	1.2213	1.4390
Geographic Region	Mountain South	1.3047	0.0534	1.1999	1.4094
Geographic Region	Pacific	1.2463	0.0239	1.1995	1.2932
Education	No Education	1.1575	0.0231	1.1123	1.2027
Education	High School or GED	1.2189	0.0168	1.1859	1.2519
Education	Some College	1.2438	0.0194	1.2056	1.2819
Education	Associate Degree	1.2447	0.0297	1.1864	1.3029
Education	Bachelor Degree	1.3056	0.0229	1.2607	1.3504
Education	Master Degree	1.3563	0.0386	1.2806	1.4320
Education	PhD or Professional Degree	1.4351	0.0717	1.2946	1.5757
Ages of People in the Household	Less than 20	1.2911	0.0164	1.2590	1.3232

Ages of People in the Household	20 to 29	1.2187	0.0184	1.1827	1.2547
Ages of People in the Household	30 to 59	1.2713	0.0118	1.2482	1.2944
Ages of People in the Household	60 or Greater	1.3020	0.0172	1.2684	1.3356
Size of the Household	1	1.0995	0.0120	1.0761	1.1230
Size of the Household	2	1.2965	0.0177	1.2619	1.3312
Size of the Household	3	1.2709	0.0239	1.2241	1.3177
Size of the Household	4	1.3487	0.0285	1.2929	1.4045
Size of the Household	5	1.3252	0.0401	1.2466	1.4037
Size of the Household	6 or More	1.4383	0.0559	1.3287	1.5480

Table 22. Average numbers of freezers, overall and by demographic variable

Demographic category	Value	Average number	Standard error	Lower 95% CI	Upper 95% CI
All Households	N/A	0.3341	0.0052	0.3240	0.3442
Race	Other	0.2278	0.0211	0.1864	0.2692
Race	White	0.3503	0.0060	0.3387	0.3620
Race	Black	0.3159	0.0131	0.2902	0.3416
Race	Asian	0.1599	0.0211	0.1186	0.2012
Income	$0 to $19,000	0.2375	0.0096	0.2187	0.2562
Income	$20,000 to $39,000	0.3123	0.0101	0.2925	0.3320
Income	$40,000 to $59,000	0.3608	0.0126	0.3361	0.3854
Income	$60,000 to $79,000	0.4017	0.0165	0.3695	0.4340
Income	$80,000 to $99,000	0.3999	0.0197	0.3613	0.4385
Income	$100,000 and more	0.3767	0.0131	0.3510	0.4024
Hispanic	Hispanic	0.1280	0.0090	0.1104	0.1457
Hispanic	Non-Hispanic	0.3645	0.0057	0.3532	0.3757
Gender	Female	0.3427	0.0072	0.3287	0.3568
Gender	Male	0.3242	0.0074	0.3097	0.3387
Geographic Region	New England	0.2136	0.0178	0.1786	0.2485
Geographic Region	Middle Atlantic	0.2529	0.0122	0.2291	0.2767
Geographic Region	East North Central	0.4034	0.0133	0.3773	0.4296
Geographic Region	West North Central	0.5281	0.0234	0.4823	0.5740
Geographic Region	South Atlantic	0.3143	0.0109	0.2928	0.3357
Geographic Region	East South Central	0.4864	0.0263	0.4349	0.5379
Geographic Region	West South Central	0.3436	0.0164	0.3115	0.3757
Geographic Region	Mountain North	0.5014	0.0378	0.4273	0.5754
Geographic Region	Mountain South	0.2726	0.0243	0.2250	0.3202

Geographic Region	Pacific	0.2117	0.0106	0.1909	0.2326
Education	No Education	0.2905	0.0143	0.2625	0.3185
Education	High School or GED	0.3615	0.0105	0.3409	0.3821
Education	Some College	0.3538	0.0109	0.3324	0.3751
Education	Associate Degree	0.3662	0.0172	0.3326	0.3999
Education	Bachelor Degree	0.3004	0.0112	0.2785	0.3222
Education	Master Degree	0.3138	0.0187	0.2773	0.3504
Education	PhD or Professional Degree	0.2594	0.0260	0.2085	0.3104
Ages of People in the Household	Less than 20	0.3533	0.0085	0.3366	0.3699
Ages of People in the Household	20 to 29	0.2495	0.0094	0.2311	0.2680
Ages of People in the Household	30 to 59	0.3410	0.0063	0.3286	0.3533
Ages of People in the Household	60 or Greater	0.4251	0.0100	0.4055	0.4448
Size of the Household	1	0.2021	0.0077	0.1869	0.2173
Size of the Household	2	0.3970	0.0102	0.3770	0.4171
Size of the Household	3	0.3376	0.0120	0.3140	0.3613
Size of the Household	4	0.3704	0.0147	0.3417	0.3992
Size of the Household	5	0.4103	0.0206	0.3699	0.4506
Size of the Household	6 or More	0.4693	0.0288	0.4128	0.5258

Table 23. Average numbers of TVs, overall and by demographic variable

Demographic category	Value	Average number	Standard error	Lower 95% CI	Upper 95% CI
All Households	N/A	2.6566	0.0263	2.7081	2.6050
Race	Other	2.6435	0.1291	2.8965	2.3905
Race	White	2.6342	0.0293	2.6916	2.5768
Race	Black	2.8830	0.0767	3.0333	2.7327
Race	Asian	2.2798	0.1333	2.5411	2.0186
Income	$0 to $19,000	2.1772	0.0520	2.2791	2.0752
Income	$20,000 to $39,000	2.4560	0.0500	2.5541	2.3580
Income	$40,000 to $59,000	2.6702	0.0599	2.7876	2.5529
Income	$60,000 to $79,000	2.7146	0.0810	2.8733	2.5558
Income	$80,000 to $99,000	2.9126	0.0820	3.0734	2.7518
Income	$100,000 and more	3.1604	0.0716	3.3006	3.0201
Hispanic	Hispanic	2.6747	0.0742	2.8202	2.5292
Hispanic	Non-Hispanic	2.6541	0.0281	2.7092	2.5989

Gender	Female	2.6602	0.0360	2.7308	2.5896
Gender	Male	2.6524	0.0385	2.7279	2.5769
Geographic Region	New England	2.5509	0.1128	2.7721	2.3297
Geographic Region	Middle Atlantic	2.6055	0.0685	2.7397	2.4713
Geographic Region	East North Central	2.7885	0.0701	2.9258	2.6511
Geographic Region	West North Central	2.6854	0.1025	2.8864	2.4845
Geographic Region	South Atlantic	2.7479	0.0600	2.8654	2.6303
Geographic Region	East South Central	2.6621	0.1046	2.8671	2.4571
Geographic Region	West South Central	2.6617	0.0801	2.8186	2.5047
Geographic Region	Mountain North	2.6891	0.1490	2.9811	2.3971
Geographic Region	Mountain South	2.6379	0.1439	2.9199	2.3559
Geographic Region	Pacific	2.4602	0.0637	2.5849	2.3354
Education	No Education	2.4087	0.0754	2.5564	2.2609
Education	High School or GED	2.6448	0.0502	2.7431	2.5465
Education	Some College	2.7449	0.0575	2.8575	2.6323
Education	Associate Degree	2.7308	0.0859	2.8991	2.5624
Education	Bachelor Degree	2.6994	0.0597	2.8163	2.5824
Education	Master Degree	2.6144	0.0917	2.7942	2.4346
Education	PhD or Professional Degree	2.4841	0.1477	2.7735	2.1947
Ages of People in the Household	Less than 20	3.1093	0.0485	3.2045	3.0142
Ages of People in the Household	20 to 29	2.7893	0.0588	2.9046	2.6740
Ages of People in the Household	30 to 59	2.8283	0.0337	2.8943	2.7623
Ages of People in the Household	60 or Greater	2.5266	0.0423	2.6095	2.4437
Size of the Household	1	1.9418	0.0381	2.0165	1.8670
Size of the Household	2	2.5579	0.0432	2.6427	2.4732
Size of the Household	3	2.9284	0.0688	3.0633	2.7935
Size of the Household	4	3.2272	0.0795	3.3829	3.0715
Size of the Household	5	3.3056	0.1179	3.5367	3.0746
Size of the Household	6 or More	3.5506	0.1542	3.8529	3.2483

9.2.2 IMS Research and NCTA

Table 24. Proportions of primary service providers in IMS Research and NCTA data.

	IMS	NCTA	Combined
Total Counts	100,547,000	97,080,000	100,836,000
Provider proportions			
AT&T	4.43%	4.27%	4.27%
Bright House	2.01%	2.12%	2.02%
Cablevision	3.24%	3.35%	3.23%
Charter	4.03%	4.40%	4.13%
Comcast	21.65%	22.78%	21.76%
Cox	4.63%	4.80%	4.62%
DirecTV	19.83%	20.51%	19.76%
Dish Network	13.96%	14.48%	13.93%
Mediacom	0.95%	1.07%	0.99%
other	7.38%	3.47%	7.35%
Suddenlink	1.30%	1.27%	1.26%
Time Warner	11.90%	12.86%	12.12%
Verizon	4.69%	4.61%	4.55%

9.2.3 RP survey

Table 25. Proportions of numbers of refrigerators

No weight	Number of samples:		3011				
Value	**Proportion**	**Standard error**	**Lower 95% CI**	**Upper 95% CI**	**Difference from RECS**	**Lower 95% CI**	**Upper 95% CI**
0	1.16%	0.20%	0.70%	1.77%	0.99%	0.60%	1.38%
1	69.91%	0.84%	67.64%	72.08%	-7.00%	-8.80%	-5.20%
2	24.05%	0.78%	22.00%	26.14%	3.30%	1.61%	4.98%
3	4.09%	0.36%	3.18%	5.12%	2.25%	1.50%	2.99%
4	0.73%	0.16%	0.38%	1.23%	0.49%	0.18%	0.81%
5+	0.07%	0.05%	0.00%	0.30%	-0.03%	-0.14%	0.08%
Sequential	Number of samples:		3006.3				
0	1.93%	0.25%	1.32%	2.68%	1.76%	1.26%	2.26%
1	73.03%	0.81%	70.82%	75.12%	-3.88%	-5.63%	-2.12%
2	21.80%	0.75%	19.83%	23.84%	1.06%	-0.59%	2.70%
3	2.66%	0.29%	1.93%	3.51%	0.82%	0.20%	1.44%
4	0.57%	0.14%	0.26%	1.03%	0.33%	0.05%	0.61%
5+	0.01%	0.02%	0.00%	0.19%	-0.09%	-0.15%	-0.02%
Simultaneous	Number of samples:		3001.8				
0	1.41%	0.21%	0.89%	2.06%	1.24%	0.81%	1.67%
1	75.34%	0.79%	73.18%	77.37%	-1.57%	-3.29%	0.15%

2	19.83%	0.73%	17.93%	21.80%	-0.92%	-2.52%	0.68%
3	3.04%	0.31%	2.26%	3.95%	1.20%	0.54%	1.86%
4	0.34%	0.11%	0.11%	0.72%	0.10%	-0.13%	0.32%
5+	0.04%	0.04%	0.00%	0.26%	-0.05%	-0.15%	0.04%

Table 26. Proportions of numbers of freezers

No weight	Number of samples:		3011				
Value	**Proportion**	**Standard error**	**Lower 95% CI**	**Upper 95% CI**	**Difference from RECS**	**Lower 95% CI**	**Upper 95% CI**
0	66.27%	0.86%	64.00%	68.54%	-3.28%	-5.81%	-0.76%
1	30.72%	0.84%	28.50%	32.93%	2.83%	0.37%	5.29%
2	2.62%	0.29%	1.85%	3.38%	0.45%	-0.39%	1.30%
3	0.36%	0.11%	0.08%	0.65%	-0.03%	-0.36%	0.29%
4	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
5+	0.03%	0.03%	0.00%	0.12%	0.03%	-0.05%	0.12%
Sequential	Number of samples:		3018.0				
0	69.88%	0.84%	67.68%	72.09%	0.33%	-2.13%	2.79%
1	26.93%	0.81%	24.80%	29.06%	-0.96%	-3.34%	1.43%
2	2.99%	0.31%	2.17%	3.81%	0.83%	-0.06%	1.71%
3	0.19%	0.08%	0.00%	0.40%	-0.21%	-0.47%	0.05%
4	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
5+	0.01%	0.02%	0.00%	0.05%	0.01%	-0.03%	0.05%
Simultaneous	Number of samples:		3009.3				
0	68.69%	0.85%	66.46%	70.92%	-0.87%	-3.35%	1.62%
1	28.11%	0.82%	25.94%	30.27%	0.22%	-2.19%	2.64%
2	2.87%	0.30%	2.07%	3.67%	0.71%	-0.17%	1.58%
3	0.34%	0.11%	0.06%	0.61%	-0.06%	-0.38%	0.25%
4	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
5+	0.00%	0.01%	0.00%	0.02%	0.00%	-0.02%	0.02%

Table 27. Proportions of numbers of refrigerators and freezers

No weight		Number of samples:		3009				
Freezers	**Refrigerators**	**Proportion**	**Standard error**	**Lower 95% CI**	**Upper 95% CI**	**Difference from RECS**	**Lower 95% CI**	**Upper 95% CI**
0	0	0.96%	0.18%	0.42%	1.51%	0.81%	0.25%	1.37%
0	1	49.85%	0.91%	47.04%	52.66%	-6.89%	-10.02%	-3.76%
0	2	13.23%	0.62%	11.33%	15.13%	1.65%	-0.45%	3.75%
0	3	1.76%	0.24%	1.02%	2.50%	0.84%	0.05%	1.62%
0	4	0.33%	0.10%	0.01%	0.66%	0.22%	-0.11%	0.56%
0	5+	0.03%	0.03%	0.00%	0.14%	-0.02%	-0.14%	0.10%
1	0	0.17%	0.07%	0.00%	0.39%	0.15%	-0.08%	0.38%
1	1	19.04%	0.72%	16.84%	21.25%	0.16%	-2.30%	2.62%
1	2	9.47%	0.53%	7.83%	11.11%	1.36%	-0.45%	3.17%
1	3	1.89%	0.25%	1.13%	2.66%	1.16%	0.36%	1.96%
1	4	0.23%	0.09%	0.00%	0.50%	0.12%	-0.17%	0.41%
1	5+	0.00%	0.00%	0.00%	0.00%	-0.03%	-0.08%	0.02%
2	0	0.03%	0.03%	0.00%	0.14%	0.03%	-0.07%	0.14%
2	1	0.93%	0.18%	0.39%	1.47%	-0.23%	-0.85%	0.39%
2	2	1.30%	0.21%	0.66%	1.93%	0.39%	-0.29%	1.08%
2	3	0.30%	0.10%	0.00%	0.61%	0.22%	-0.09%	0.54%
2	4	0.07%	0.05%	0.00%	0.21%	0.05%	-0.10%	0.20%
2	5+	0.00%	0.00%	0.00%	0.00%	-0.01%	-0.03%	0.02%
3+	0	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
3+	1	0.07%	0.05%	0.00%	0.21%	-0.06%	-0.23%	0.12%
3+	2	0.07%	0.05%	0.00%	0.21%	-0.09%	-0.27%	0.09%
3+	3	0.13%	0.07%	0.00%	0.34%	0.03%	-0.20%	0.25%
3+	4	0.10%	0.06%	0.00%	0.28%	0.10%	-0.08%	0.27%
3+	5+	0.03%	0.03%	0.00%	0.14%	0.03%	-0.08%	0.13%
Sequential		Number of samples:		3005.8				

0	0	1.73%	0.24%	1.00%	2.46%	1.57%	0.83%	2.31%
0	1	52.77%	0.91%	49.97%	55.57%	-3.97%	-7.10%	-0.84%
0	2	13.48%	0.62%	11.56%	15.40%	1.90%	-0.22%	4.02%
0	3	1.40%	0.21%	0.74%	2.06%	0.47%	-0.24%	1.18%
0	4	0.39%	0.11%	0.04%	0.73%	0.28%	-0.08%	0.64%
0	5+	0.00%	0.00%	0.00%	0.01%	-0.05%	-0.11%	0.01%
1	0	0.09%	0.05%	0.00%	0.26%	0.08%	-0.10%	0.25%
1	1	18.58%	0.71%	16.39%	20.76%	-0.31%	-2.75%	2.13%
1	2	7.25%	0.47%	5.80%	8.71%	-0.86%	-2.50%	0.79%
1	3	1.00%	0.18%	0.44%	1.56%	0.27%	-0.34%	0.88%
1	4	0.12%	0.06%	0.00%	0.31%	0.01%	-0.21%	0.22%
1	5+	0.00%	0.00%	0.00%	0.00%	-0.03%	-0.08%	0.02%
2	0	0.11%	0.06%	0.00%	0.30%	0.11%	-0.08%	0.30%
2	1	1.62%	0.23%	0.91%	2.33%	0.46%	-0.31%	1.23%
2	2	1.06%	0.19%	0.48%	1.63%	0.16%	-0.48%	0.79%
2	3	0.20%	0.08%	0.00%	0.45%	0.12%	-0.14%	0.39%
2	4	0.01%	0.02%	0.00%	0.07%	-0.01%	-0.07%	0.06%
2	5+	0.00%	0.00%	0.00%	0.00%	-0.01%	-0.03%	0.02%
3+	0	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
3+	1	0.07%	0.05%	0.00%	0.21%	-0.06%	-0.23%	0.12%
3+	2	0.02%	0.02%	0.00%	0.09%	-0.14%	-0.27%	-0.01%
3+	3	0.05%	0.04%	0.00%	0.19%	-0.05%	-0.21%	0.11%
3+	4	0.06%	0.04%	0.00%	0.19%	0.05%	-0.08%	0.19%
3+	5+	0.01%	0.02%	0.00%	0.06%	0.00%	-0.05%	0.05%
Simultaneous		Number of samples:		3001.4				
0	0	1.30%	0.21%	0.66%	1.93%	1.14%	0.50%	1.79%
0	1	54.95%	0.91%	52.15%	57.75%	-1.79%	-4.91%	1.33%
0	2	10.82%	0.57%	9.08%	12.57%	-0.76%	-2.72%	1.20%
0	3	1.32%	0.21%	0.68%	1.96%	0.40%	-0.30%	1.09%
0	4	0.17%	0.08%	0.00%	0.41%	0.07%	-0.19%	0.32%

0	5+	0.04%	0.04%	0.00%	0.15%	-0.01%	-0.14%	0.12%
1	0	0.08%	0.05%	0.00%	0.23%	0.06%	-0.10%	0.22%
1	1	19.08%	0.72%	16.87%	21.28%	0.19%	-2.27%	2.66%
1	2	7.68%	0.49%	6.18%	9.17%	-0.43%	-2.11%	1.25%
1	3	1.25%	0.20%	0.63%	1.88%	0.52%	-0.15%	1.19%
1	4	0.10%	0.06%	0.00%	0.27%	-0.01%	-0.21%	0.18%
1	5+	0.00%	0.00%	0.00%	0.00%	-0.03%	-0.08%	0.02%
2	0	0.03%	0.03%	0.00%	0.14%	0.03%	-0.07%	0.14%
2	1	1.23%	0.20%	0.61%	1.85%	0.07%	-0.62%	0.75%
2	2	1.31%	0.21%	0.67%	1.94%	0.40%	-0.29%	1.09%
2	3	0.29%	0.10%	0.00%	0.59%	0.21%	-0.10%	0.52%
2	4	0.02%	0.03%	0.00%	0.11%	0.01%	-0.09%	0.10%
2	5+	0.00%	0.00%	0.00%	0.00%	-0.01%	-0.03%	0.02%
3+	0	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
3+	1	0.08%	0.05%	0.00%	0.24%	-0.04%	-0.23%	0.15%
3+	2	0.03%	0.03%	0.00%	0.12%	-0.13%	-0.28%	0.02%
3+	3	0.18%	0.08%	0.00%	0.42%	0.07%	-0.18%	0.33%
3+	4	0.05%	0.04%	0.00%	0.17%	0.04%	-0.08%	0.16%
3+	5+	0.00%	0.01%	0.00%	0.03%	-0.01%	-0.04%	0.03%

Table 28. Proportion of numbers of refrigerators and freezers in RP (sequential method)

Number of refrigerators	Number of freezers				
	0	1	2	3+	total
0	1.73%	0.09%	0.11%	0.00%	1.93%
1	52.77%	18.58%	1.62%	0.07%	73.03%
2	13.48%	7.25%	1.06%	0.02%	21.81%
3	1.40%	1.00%	0.20%	0.05%	2.66%
4	0.39%	0.12%	0.01%	0.06%	0.57%
5+	0.00%	0.00%	0.00%	0.01%	0.01%
total	69.76%	27.04%	3.00%	0.20%	100.00%

Table 29. Proportion of numbers of refrigerators and freezers in RP (simultaneous method)

Number of refrigerators	Number of freezers				
	0	1	2	3+	total
0	1.30%	0.08%	0.03%	0.00%	1.41%
1	54.95%	19.08%	1.23%	0.08%	75.34%
2	10.82%	7.68%	1.31%	0.03%	19.83%
3	1.32%	1.25%	0.29%	0.18%	3.04%
4	0.17%	0.10%	0.02%	0.05%	0.34%
5+	0.04%	0.00%	0.00%	0.00%	0.04%
total	68.60%	28.18%	2.88%	0.34%	100.00%

Table 30. Average numbers of refrigerators, overall and by demographic variable

Unweighted

Demographic category	Value	Average number	Standard error	Difference from RECS	Standard error	Lower 95% CI	Upper 95% CI
All Households	N/A	1.3351	0.0218	0.0815	0.0237	0.0351	0.1280
Race	Other	1.3756	0.0874	0.1945	0.0958	0.0066	0.3823
Race	White	1.3511	0.0252	0.0725	0.0275	0.0186	0.1263
Race	Black	1.2072	0.0538	0.0751	0.0572	-0.0370	0.1873
Race	Asian	1.3727	0.1197	0.1268	0.1300	-0.1280	0.3816
Income	$0 to $19,000	1.1627	0.0530	0.0696	0.0547	-0.0376	0.1767
Income	$20,000 to $39,000	1.1979	0.0376	0.0322	0.0408	-0.0477	0.1121
Income	$40,000 to $59,000	1.2814	0.0438	0.0484	0.0484	-0.0464	0.1433
Income	$60,000 to $79,000	1.3475	0.0561	0.0459	0.0628	-0.0772	0.1690
Income	$80,000 to $99,000	1.4825	0.0771	0.1145	0.0857	-0.0536	0.2825
Income	$100,000 and more	1.5667	0.0681	0.0359	0.0752	-0.1113	0.1832
Hispanic	Hispanic	1.3911	0.0980	0.1998	0.1007	0.0024	0.3971
Hispanic	Non-Hispanic	1.3319	0.0225	0.0691	0.0247	0.0208	0.1175
Gender	Female	1.3162	0.0284	0.0798	0.0311	0.0190	0.1407
Gender	Male	1.3592	0.0340	0.0861	0.0368	0.0139	0.1583
Geographic Region	New England	1.3413	0.0954	0.1195	0.1034	-0.0832	0.3222
Geographic Region	Middle Atlantic	1.4133	0.0634	0.1696	0.0683	0.0358	0.3034
Geographic Region	East North Central	1.3216	0.0547	0.0215	0.0602	-0.0966	0.1396
Geographic Region	West North Central	1.3483	0.0851	0.0118	0.0937	-0.1720	0.1955
Geographic Region	South Atlantic	1.3306	0.0476	0.1085	0.0517	0.0072	0.2098
Geographic Region	East South Central	1.3289	0.0933	0.1101	0.0996	-0.0851	0.3053
Geographic Region	West South Central	1.3123	0.0702	0.1065	0.0747	-0.0399	0.2529
Geographic Region	Mountain North	1.4248	0.1239	0.0946	0.1358	-0.1714	0.3607
Geographic Region	Mountain South	1.3438	0.1223	0.0391	0.1335	-0.2226	0.3008
Geographic Region	Pacific	1.2822	0.0496	0.0359	0.0551	-0.0721	0.1439

Education	No Education	1.2778	0.1830	0.1202	0.1844	-0.2412	0.4817
Education	High School or GED	1.2766	0.0497	0.0577	0.0525	-0.0451	0.1605
Education	Some College	1.3561	0.0393	0.1124	0.0438	0.0265	0.1982
Education	Associate Degree	1.3630	0.0759	0.1183	0.0816	-0.0416	0.2781
Education	Bachelor Degree	1.3314	0.0403	0.0258	0.0463	-0.0650	0.1166
Education	Master Degree	1.3432	0.0709	-0.0131	0.0808	-0.1714	0.1451
Education	PhD or Professional Degree	1.3333	0.1405	-0.1018	0.1578	-0.4110	0.2074
Ages of People in the Household	Less than 20	1.4035	0.0346	0.1123	0.0383	0.0373	0.1874
Ages of People in the Household	20 to 29	1.3452	0.0291	0.1266	0.0344	0.0591	0.1941
Ages of People in the Household	30 to 59	1.3814	0.0274	0.1101	0.0298	0.0516	0.1685
Ages of People in the Household	60 or Greater	1.4783	0.0507	0.1763	0.0535	0.0715	0.2812
Size of the Household	1	1.0200	0.0315	-0.0795	0.0337	-0.1457	-0.0134
Size of the Household	2	1.2191	0.0337	-0.0775	0.0380	-0.1519	-0.0030
Size of the Household	3	1.3389	0.0443	0.0680	0.0503	-0.0305	0.1666
Size of the Household	4	1.4446	0.0538	0.0959	0.0608	-0.0233	0.2152
Size of the Household	5	1.5188	0.0762	0.1937	0.0861	0.0250	0.3624
Size of the Household	6 or More	1.6462	0.1124	0.2078	0.1255	-0.0382	0.4539

Sequential method

Demographic category	Value	Average number	Standard error	Difference from RECS	Standard error	Lower 95% CI	Upper 95% CI
All Households	N/A	1.2692	0.0200	0.0157	0.0221	-0.0276	0.0590
Race	Other	1.0827	0.0973	-0.0984	0.1050	-0.3042	0.1073
Race	White	1.2928	0.0230	0.0142	0.0255	-0.0357	0.0641
Race	Black	1.1510	0.0442	0.0189	0.0482	-0.0756	0.1134
Race	Asian	1.3271	0.1300	0.0813	0.1395	-0.1921	0.3547
Income	$0 to $19,000	1.0639	0.0310	-0.0293	0.0337	-0.0953	0.0367

Income	$20,000 to $39,000	1.1608	0.0337	-0.0049	0.0373	-0.0779	0.0682
Income	$40,000 to $59,000	1.2032	0.0410	-0.0297	0.0458	-0.1196	0.0601
Income	$60,000 to $79,000	1.4315	0.0697	0.1299	0.0751	-0.0174	0.2772
Income	$80,000 to $99,000	1.4667	0.0833	0.0986	0.0913	-0.0803	0.2775
Income	$100,000 and more	1.5014	0.0650	-0.0294	0.0724	-0.1712	0.1125
Hispanic	Hispanic	1.3741	0.0631	0.1828	0.0673	0.0510	0.3146
Hispanic	Non-Hispanic	1.2549	0.0212	-0.0078	0.0235	-0.0538	0.0382
Gender	Female	1.2621	0.0268	0.0258	0.0296	-0.0323	0.0838
Gender	Male	1.2763	0.0301	0.0033	0.0332	-0.0619	0.0684
Geographic Region	New England	1.2154	0.0830	-0.0065	0.0921	-0.1870	0.1740
Geographic Region	Middle Atlantic	1.3841	0.0621	0.1405	0.0670	0.0091	0.2719
Geographic Region	East North Central	1.2746	0.0501	-0.0255	0.0561	-0.1355	0.0845
Geographic Region	West North Central	1.2196	0.0702	-0.1169	0.0804	-0.2746	0.0407
Geographic Region	South Atlantic	1.1830	0.0403	-0.0392	0.0450	-0.1274	0.0490
Geographic Region	East South Central	1.2446	0.0745	0.0257	0.0823	-0.1356	0.1870
Geographic Region	West South Central	1.2885	0.0642	0.0827	0.0691	-0.0528	0.2181
Geographic Region	Mountain North	1.2725	0.1062	-0.0577	0.1198	-0.2925	0.1771
Geographic Region	Mountain South	1.2690	0.1115	-0.0357	0.1237	-0.2781	0.2067
Geographic Region	Pacific	1.3064	0.0506	0.0600	0.0560	-0.0497	0.1697
Education	No Education	1.3079	0.0587	0.1504	0.0630	0.0268	0.2739
Education	High School or GED	1.1896	0.0358	-0.0293	0.0396	-0.1068	0.0483
Education	Some College	1.2721	0.0416	0.0283	0.0459	-0.0617	0.1184
Education	Associate Degree	1.3187	0.0719	0.0740	0.0778	-0.0785	0.2265
Education	Bachelor Degree	1.2909	0.0457	-0.0147	0.0511	-0.1148	0.0855
Education	Master Degree	1.2894	0.0723	-0.0669	0.0820	-0.2275	0.0937
Education	PhD or Professional Degree	1.3351	0.1295	-0.1000	0.1480	-0.3902	0.1901
Ages of People in the Household	Less than 20	1.3486	0.0372	0.0575	0.0407	-0.0222	0.1373
Ages of People in the Household	20 to 29	1.2674	0.0418	0.0487	0.0456	-0.0407	0.1381

Ages of People in the Household	30 to 59	1.3101	0.0258	0.0388	0.0283	-0.0167	0.0944
Ages of People in the Household	60 or Greater	1.3706	0.0381	0.0686	0.0418	-0.0132	0.1505
Size of the Household	1	1.0306	0.0208	-0.0689	0.0240	-0.1160	-0.0218
Size of the Household	2	1.2839	0.0348	-0.0126	0.0391	-0.0891	0.0639
Size of the Household	3	1.3070	0.0530	0.0361	0.0581	-0.0778	0.1500
Size of the Household	4	1.4846	0.0664	0.1359	0.0722	-0.0057	0.2775
Size of the Household	5	1.5230	0.0968	0.1978	0.1048	-0.0075	0.4031
Size of the Household	6 or More	1.4377	0.1210	-0.0006	0.1333	-0.2619	0.2606

Simultaneous method

Demographic category	Value	Average number	Standard error	Difference from RECS	Standard error	Lower 95% CI	Upper 95% CI
All Households	N/A	1.2569	0.0196	0.0034	0.0217	-0.0392	0.0459
Race	Other	1.3115	0.0848	0.1304	0.0935	-0.0528	0.3136
Race	White	1.2720	0.0229	-0.0066	0.0254	-0.0564	0.0432
Race	Black	1.1513	0.0426	0.0192	0.0468	-0.0726	0.1110
Race	Asian	1.3102	0.1186	0.0643	0.1289	-0.1884	0.3170
Income	$0 to $19,000	1.0450	0.0337	-0.0481	0.0362	-0.1191	0.0228
Income	$20,000 to $39,000	1.1339	0.0314	-0.0318	0.0352	-0.1008	0.0372
Income	$40,000 to $59,000	1.2123	0.0384	-0.0207	0.0435	-0.1059	0.0645
Income	$60,000 to $79,000	1.3811	0.0603	0.0795	0.0666	-0.0510	0.2099
Income	$80,000 to $99,000	1.4468	0.0795	0.0787	0.0879	-0.0935	0.2510
Income	$100,000 and more	1.4823	0.0684	-0.0485	0.0755	-0.1964	0.0994
Hispanic	Hispanic	1.4171	0.0692	0.2258	0.0731	0.0826	0.3690
Hispanic	Non-Hispanic	1.2345	0.0202	-0.0282	0.0226	-0.0724	0.0160
Gender	Female	1.2563	0.0254	0.0199	0.0283	-0.0355	0.0753
Gender	Male	1.2597	0.0312	-0.0134	0.0342	-0.0805	0.0537
Geographic Region	New England	1.1967	0.0789	-0.0252	0.0884	-0.1985	0.1482
Geographic Region	Middle Atlantic	1.3341	0.0592	0.0905	0.0643	-0.0355	0.2165

Geographic Region	East North Central	1.2597	0.0500	-0.0404	0.0560	-0.1503	0.0694
Geographic Region	West North Central	1.2938	0.0780	-0.0426	0.0873	-0.2138	0.1285
Geographic Region	South Atlantic	1.1994	0.0393	-0.0227	0.0442	-0.1094	0.0639
Geographic Region	East South Central	1.2281	0.0705	0.0093	0.0787	-0.1451	0.1636
Geographic Region	West South Central	1.2351	0.0564	0.0293	0.0620	-0.0921	0.1508
Geographic Region	Mountain North	1.4048	0.1203	0.0747	0.1325	-0.1851	0.3344
Geographic Region	Mountain South	1.3329	0.1612	0.0282	0.1699	-0.3047	0.3611
Geographic Region	Pacific	1.2474	0.0491	0.0010	0.0546	-0.1060	0.1080
Education	No Education	1.1233	0.1279	-0.0343	0.1300	-0.2891	0.2205
Education	High School or GED	1.1711	0.0356	-0.0478	0.0394	-0.1250	0.0294
Education	Some College	1.2861	0.0388	0.0423	0.0434	-0.0427	0.1274
Education	Associate Degree	1.2823	0.0664	0.0376	0.0727	-0.1049	0.1802
Education	Bachelor Degree	1.2737	0.0391	-0.0319	0.0453	-0.1206	0.0569
Education	Master Degree	1.2974	0.0680	-0.0590	0.0782	-0.2123	0.0944
Education	PhD or Professional Degree	1.2833	0.1163	-0.1519	0.1366	-0.4196	0.1158
Ages of People in the Household	Less than 20	1.3561	0.0361	0.0650	0.0396	-0.0127	0.1426
Ages of People in the Household	20 to 29	1.3336	0.0448	0.1150	0.0484	0.0201	0.2099
Ages of People in the Household	30 to 59	1.2830	0.0228	0.0117	0.0257	-0.0386	0.0620
Ages of People in the Household	60 or Greater	1.4094	0.0448	0.1074	0.0479	0.0135	0.2014
Size of the Household	1	1.0143	0.0173	-0.0852	0.0211	-0.1265	-0.0440
Size of the Household	2	1.2463	0.0333	-0.0503	0.0377	-0.1242	0.0236
Size of the Household	3	1.3209	0.0537	0.0500	0.0588	-0.0652	0.1651
Size of the Household	4	1.4494	0.0643	0.1007	0.0703	-0.0372	0.2386
Size of the Household	5	1.4556	0.0912	0.1304	0.0996	-0.0649	0.3257
Size of the Household	6 or More	1.6829	0.1340	0.2445	0.1452	-0.0400	0.5291

Table 31. Average numbers of freezers, overall and by demographic variable

Unweighted

Demographic category	Value	Average number	Standard error	Difference from RECS	Standard error	Lower 95% CI	Upper 95% CI
All Households	N/A	0.3721	0.0109	0.0380	0.0120	0.0145	0.0616
Race	Other	0.3874	0.0437	0.1595	0.0486	0.0644	0.2547
Race	White	0.3825	0.0124	0.0322	0.0138	0.0052	0.0591
Race	Black	0.3183	0.0311	0.0024	0.0338	-0.0637	0.0686
Race	Asian	0.3000	0.0550	0.1401	0.0589	0.0246	0.2556
Income	$0 to $19,000	0.2604	0.0287	0.0229	0.0303	-0.0364	0.0822
Income	$20,000 to $39,000	0.3501	0.0216	0.0379	0.0239	-0.0089	0.0846
Income	$40,000 to $59,000	0.3800	0.0238	0.0192	0.0269	-0.0335	0.0719
Income	$60,000 to $79,000	0.3750	0.0270	-0.0267	0.0316	-0.0887	0.0352
Income	$80,000 to $99,000	0.4301	0.0371	0.0302	0.0420	-0.0521	0.1125
Income	$100,000 and more	0.4457	0.0315	0.0690	0.0341	0.0022	0.1358
Hispanic	Hispanic	0.3222	0.0428	0.1942	0.0437	0.1085	0.2799
Hispanic	Non-Hispanic	0.3733	0.0112	0.0088	0.0126	-0.0159	0.0335
Gender	Female	0.3880	0.0147	0.0453	0.0164	0.0132	0.0774
Gender	Male	0.3472	0.0160	0.0230	0.0176	-0.0115	0.0575
Geographic Region	New England	0.3234	0.0485	0.1098	0.0517	0.0085	0.2111
Geographic Region	Middle Atlantic	0.3342	0.0286	0.0813	0.0311	0.0203	0.1422
Geographic Region	East North Central	0.4120	0.0278	0.0086	0.0309	-0.0519	0.0691
Geographic Region	West North Central	0.4975	0.0471	-0.0306	0.0526	-0.1337	0.0725
Geographic Region	South Atlantic	0.3569	0.0231	0.0427	0.0256	-0.0075	0.0928
Geographic Region	East South Central	0.4539	0.0544	-0.0325	0.0604	-0.1509	0.0860
Geographic Region	West South Central	0.3427	0.0340	-0.0010	0.0377	-0.0749	0.0729
Geographic Region	Mountain North	0.5487	0.0715	0.0473	0.0809	-0.1112	0.2058
Geographic Region	Mountain South	0.4167	0.0695	0.1441	0.0736	-0.0002	0.2883
Geographic Region	Pacific	0.2924	0.0224	0.0807	0.0248	0.0322	0.1293
Education	No Education	0.3889	0.0958	0.0984	0.0968	-0.0914	0.2882

Education	High School or GED	0.3719	0.0263	0.0103	0.0284	-0.0452	0.0659
Education	Some College	0.3971	0.0194	0.0434	0.0223	-0.0003	0.0870
Education	Associate Degree	0.4333	0.0381	0.0671	0.0418	-0.0148	0.1490
Education	Bachelor Degree	0.3337	0.0192	0.0334	0.0222	-0.0102	0.0769
Education	Master Degree	0.3419	0.0376	0.0281	0.0420	-0.0542	0.1104
Education	PhD or Professional Degree	0.3067	0.0647	0.0472	0.0697	-0.0895	0.1839
Ages of People in the Household	Less than 20	0.4482	0.0176	0.0949	0.0195	0.0567	0.1332
Ages of People in the Household	20 to 29	0.3511	0.0139	0.1016	0.0168	0.0687	0.1345
Ages of People in the Household	30 to 59	0.4260	0.0139	0.0850	0.0152	0.0552	0.1149
Ages of People in the Household	60 or Greater	0.4797	0.0254	0.0545	0.0273	0.0010	0.1081
Size of the Household	1	0.1722	0.0217	-0.0299	0.0231	-0.0751	0.0153
Size of the Household	2	0.2776	0.0175	-0.1194	0.0203	-0.1592	-0.0796
Size of the Household	3	0.3668	0.0213	0.0292	0.0245	-0.0188	0.0771
Size of the Household	4	0.4613	0.0279	0.0908	0.0315	0.0292	0.1525
Size of the Household	5	0.5058	0.0354	0.0955	0.0409	0.0153	0.1757
Size of the Household	6 or More	0.6000	0.0558	0.1307	0.0628	0.0077	0.2537

Sequential method

Demographic category	**Value**	**Average number**	**Standard error**	**Difference from RECS**	**Standard error**	**Lower 95% CI**	**Upper 95% CI**
All Households	N/A	0.3352	0.0105	0.0011	0.0117	-0.0218	0.0240
Race	Other	0.4072	0.0600	0.1793	0.0636	0.0547	0.3040
Race	White	0.3412	0.0115	-0.0091	0.0129	-0.0344	0.0162
Race	Black	0.2176	0.0245	-0.0983	0.0278	-0.1528	-0.0438
Race	Asian	0.6443	0.1013	0.4844	0.1034	0.2817	0.6871
Income	$0 to $19,000	0.2045	0.0189	-0.0330	0.0212	-0.0746	0.0086
Income	$20,000 to $39,000	0.3773	0.0240	0.0650	0.0260	0.0140	0.1160

Income	$40,000 to $59,000	0.3645	0.0238	0.0037	0.0269	-0.0490	0.0564
Income	$60,000 to $79,000	0.3966	0.0330	-0.0052	0.0369	-0.0775	0.0671
Income	$80,000 to $99,000	0.3756	0.0374	-0.0243	0.0423	-0.1072	0.0586
Income	$100,000 and more	0.3451	0.0274	-0.0315	0.0304	-0.0911	0.0280
Hispanic	Hispanic	0.3390	0.0281	0.2109	0.0295	0.1531	0.2687
Hispanic	Non-Hispanic	0.3338	0.0113	-0.0306	0.0127	-0.0555	-0.0057
Gender	Female	0.3630	0.0145	0.0203	0.0162	-0.0115	0.0521
Gender	Male	0.3013	0.0150	-0.0229	0.0167	-0.0558	0.0099
Geographic Region	New England	0.3677	0.0518	0.1541	0.0547	0.0468	0.2614
Geographic Region	Middle Atlantic	0.2653	0.0268	0.0124	0.0295	-0.0454	0.0701
Geographic Region	East North Central	0.3276	0.0252	-0.0759	0.0285	-0.1317	-0.0200
Geographic Region	West North Central	0.5347	0.0411	0.0066	0.0473	-0.0861	0.0992
Geographic Region	South Atlantic	0.3039	0.0218	-0.0103	0.0244	-0.0581	0.0374
Geographic Region	East South Central	0.4036	0.0467	-0.0828	0.0536	-0.1879	0.0222
Geographic Region	West South Central	0.4578	0.0393	0.1141	0.0425	0.0308	0.1975
Geographic Region	Mountain North	0.5359	0.0677	0.0346	0.0776	-0.1175	0.1866
Geographic Region	Mountain South	0.3209	0.0520	0.0483	0.0574	-0.0642	0.1607
Geographic Region	Pacific	0.1791	0.0200	-0.0326	0.0226	-0.0770	0.0117
Education	No Education	0.3323	0.0357	0.0419	0.0384	-0.0335	0.1172
Education	High School or GED	0.3408	0.0205	-0.0207	0.0230	-0.0658	0.0243
Education	Some College	0.3227	0.0210	-0.0310	0.0237	-0.0774	0.0154
Education	Associate Degree	0.3896	0.0338	0.0234	0.0379	-0.0508	0.0977
Education	Bachelor Degree	0.3296	0.0238	0.0292	0.0263	-0.0222	0.0807
Education	Master Degree	0.3158	0.0352	0.0020	0.0399	-0.0761	0.0801
Education	PhD or Professional Degree	0.2498	0.0502	-0.0096	0.0566	-0.1205	0.1012
Ages of People in the Household	Less than 20	0.3963	0.0196	0.0431	0.0214	0.0011	0.0850
Ages of People in the Household	20 to 29	0.3284	0.0205	0.0788	0.0225	0.0346	0.1230
Ages of People in the	30 to 59	0.3860	0.0140	0.0451	0.0153	0.0151	0.0751

Household							
Ages of People in the Household	60 or Greater	0.3507	0.0186	-0.0744	0.0211	-0.1158	-0.0331
Size of the Household	1	0.1881	0.0136	-0.0140	0.0156	-0.0446	0.0167
Size of the Household	2	0.3398	0.0178	-0.0573	0.0206	-0.0976	-0.0170
Size of the Household	3	0.4177	0.0326	0.0801	0.0347	0.0121	0.1481
Size of the Household	4	0.4134	0.0320	0.0430	0.0352	-0.0260	0.1119
Size of the Household	5	0.4513	0.0448	0.0410	0.0493	-0.0556	0.1376
Size of the Household	6 or More	0.4857	0.0577	0.0164	0.0645	-0.1100	0.1429

Simultaneous method

Demographic category	**Value**	**Average number**	**Standard error**	**Difference from RECS**	**Standard error**	**Lower 95% CI**	**Upper 95% CI**
All Households	N/A	0.3486	0.0107	0.0146	0.0119	-0.0087	0.0378
Race	Other	0.3471	0.0428	0.1193	0.0477	0.0257	0.2129
Race	White	0.3743	0.0126	0.0239	0.0140	-0.0034	0.0513
Race	Black	0.2443	0.0258	-0.0716	0.0289	-0.1282	-0.0149
Race	Asian	0.2399	0.0522	0.0800	0.0563	-0.0302	0.1903
Income	$0 to $19,000	0.1946	0.0226	-0.0429	0.0245	-0.0909	0.0051
Income	$20,000 to $39,000	0.3411	0.0205	0.0288	0.0228	-0.0159	0.0735
Income	$40,000 to $59,000	0.3770	0.0233	0.0163	0.0265	-0.0356	0.0681
Income	$60,000 to $79,000	0.3951	0.0307	-0.0066	0.0348	-0.0749	0.0616
Income	$80,000 to $99,000	0.4273	0.0409	0.0274	0.0454	-0.0616	0.1163
Income	$100,000 and more	0.3962	0.0330	0.0195	0.0355	-0.0501	0.0891
Hispanic	Hispanic	0.3187	0.0317	0.1907	0.0330	0.1260	0.2553
Hispanic	Non-Hispanic	0.3471	0.0113	-0.0173	0.0127	-0.0421	0.0075
Gender	Female	0.3849	0.0147	0.0422	0.0164	0.0100	0.0743
Gender	Male	0.2986	0.0153	-0.0256	0.0170	-0.0590	0.0077
Geographic Region	New England	0.4154	0.0481	0.2018	0.0513	0.1013	0.3023
Geographic Region	Middle Atlantic	0.2914	0.0276	0.0385	0.0302	-0.0206	0.0977
Geographic Region	East North Central	0.3910	0.0278	-0.0125	0.0308	-0.0728	0.0479

Geographic Region	West North Central	0.5297	0.0449	0.0015	0.0507	-0.0977	0.1008
Geographic Region	South Atlantic	0.2780	0.0208	-0.0362	0.0235	-0.0824	0.0099
Geographic Region	East South Central	0.4099	0.0535	-0.0765	0.0596	-0.1932	0.0402
Geographic Region	West South Central	0.2896	0.0286	-0.0540	0.0330	-0.1186	0.0106
Geographic Region	Mountain North	0.7040	0.0763	0.2026	0.0852	0.0357	0.3696
Geographic Region	Mountain South	0.3808	0.0937	0.1082	0.0968	-0.0815	0.2978
Geographic Region	Pacific	0.2814	0.0235	0.0697	0.0258	0.0191	0.1203
Education	No Education	0.4593	0.0903	0.1688	0.0914	-0.0103	0.3479
Education	High School or GED	0.2937	0.0210	-0.0679	0.0235	-0.1138	-0.0219
Education	Some College	0.4042	0.0216	0.0505	0.0242	0.0030	0.0979
Education	Associate Degree	0.4627	0.0365	0.0965	0.0403	0.0174	0.1756
Education	Bachelor Degree	0.3068	0.0196	0.0064	0.0226	-0.0378	0.0506
Education	Master Degree	0.3535	0.0388	0.0397	0.0430	-0.0447	0.1241
Education	PhD or Professional Degree	0.1437	0.0389	-0.1157	0.0468	-0.2074	-0.0240
Ages of People in the Household	Less than 20	0.4111	0.0188	0.0578	0.0206	0.0174	0.0982
Ages of People in the Household	20 to 29	0.3347	0.0211	0.0852	0.0231	0.0400	0.1304
Ages of People in the Household	30 to 59	0.3812	0.0128	0.0403	0.0142	0.0124	0.0682
Ages of People in the Household	60 or Greater	0.4330	0.0242	0.0078	0.0262	-0.0434	0.0591
Size of the Household	1	0.1764	0.0133	-0.0257	0.0154	-0.0559	0.0045
Size of the Household	2	0.3513	0.0194	-0.0457	0.0219	-0.0886	-0.0028
Size of the Household	3	0.3926	0.0277	0.0550	0.0302	-0.0042	0.1141
Size of the Household	4	0.4919	0.0355	0.1215	0.0384	0.0461	0.1968
Size of the Household	5	0.5241	0.0488	0.1138	0.0529	0.0101	0.2175
Size of the Household	6 or More	0.5146	0.0585	0.0453	0.0652	-0.0825	0.1731

9.2.4 TS survey

Table 32. Proportions of the numbers of TVs in AMT, showing unweighted, sequential weighting and simultaneous weighting results

No weight	Number of samples:		2274				
Value	**Proportion**	**Standard error**	**Lower 95% CI**	**Upper 95% CI**	**Difference from RECS**	**Lower 95% CI**	**Upper 95% CI**
1	16.67%	0.78%	14.65%	18.68%	-0.81%	-3.05%	1.43%
2	30.69%	0.97%	28.20%	33.19%	-2.47%	-5.24%	0.31%
3	26.25%	0.92%	23.88%	28.63%	0.87%	-1.76%	3.50%
4	16.40%	0.78%	14.40%	18.40%	2.21%	0.02%	4.40%
5+	9.98%	0.63%	8.36%	11.60%	0.19%	-1.60%	1.98%
Sequential	Number of samples:		2275.2				
1	17.56%	0.80%	15.50%	19.61%	0.08%	-2.20%	2.36%
2	33.32%	0.99%	30.78%	35.87%	0.16%	-2.66%	2.99%
3	21.96%	0.87%	19.73%	24.20%	-3.42%	-5.92%	-0.92%
4	17.85%	0.80%	15.79%	19.92%	3.66%	1.40%	5.92%
5+	9.30%	0.61%	7.74%	10.87%	-0.49%	-2.23%	1.26%
Simultaneous	Number of samples:		2269.1				
1	19.69%	0.83%	17.54%	21.84%	2.21%	-0.15%	4.58%
2	33.14%	0.99%	30.59%	35.68%	-0.02%	-2.84%	2.80%
3	24.52%	0.90%	22.20%	26.85%	-0.86%	-3.44%	1.73%
4	14.68%	0.74%	12.76%	16.59%	0.48%	-1.63%	2.60%
5+	7.97%	0.57%	6.51%	9.44%	-1.82%	-3.47%	-0.16%

Table 33. Proportions of the numbers of STBs in AMT, showing unweighted, sequential weighting and simultaneous weighting results.

No weight	Number of samples:		2274				
Value	**Proportion**	**Standard error**	**Lower 95% CI**	**Upper 95% CI**	**Difference from RECS**	**Lower 95% CI**	**Upper 95% CI**
1	38.70%	1.02%	36.07%	41.33%	10.63%	7.76%	13.51%
2	33.38%	0.99%	30.83%	35.92%	-0.17%	-3.00%	2.65%
3	16.75%	0.78%	14.74%	18.77%	-15.20%	-17.55%	-12.85%
4	7.96%	0.57%	6.50%	9.42%	2.88%	1.32%	4.45%
5+	3.21%	0.37%	2.26%	4.16%	1.86%	0.86%	2.86%
Sequential	Number of samples:		2275.2				
1	37.80%	1.02%	35.19%	40.42%	9.74%	6.87%	12.60%
2	34.34%	1.00%	31.77%	36.90%	0.78%	-2.06%	3.62%
3	13.54%	0.72%	11.70%	15.39%	-18.41%	-20.62%	-16.21%
4	11.08%	0.66%	9.39%	12.78%	6.01%	4.22%	7.79%

5+	3.24%	0.37%	2.28%	4.19%	1.89%	0.88%	2.89%
Simultaneous	Number of samples:		2269.1				
1	41.75%	1.04%	39.08%	44.41%	13.68%	10.77%	16.59%
2	32.73%	0.99%	30.19%	35.27%	-0.82%	-3.64%	1.99%
3	14.90%	0.75%	12.97%	16.82%	-17.06%	-19.33%	-14.79%
4	8.13%	0.57%	6.65%	9.61%	3.05%	1.47%	4.64%
5+	2.50%	0.33%	1.65%	3.34%	1.15%	0.25%	2.04%

Table 34. Proportions of primary service providers in AMT TS, for unweighted, sequential weighting method and simultaneous weighting methods.

No weight	Number of samples:		2246				
Value	**Proportion**	**Standard error**	**Lower 95% CI**	**Upper 95% CI**	**Difference from RECS**	**Lower 95% CI**	**Upper 95% CI**
AT&T	7.17%	0.54%	5.59%	8.74%	2.90%	1.33%	4.48%
Bright House	2.63%	0.34%	1.65%	3.60%	0.60%	-0.37%	1.58%
Cablevision	2.36%	0.32%	1.43%	3.29%	-0.87%	-1.80%	0.06%
Charter	4.36%	0.43%	3.12%	5.61%	0.24%	-1.01%	1.48%
Comcast	28.94%	0.96%	26.17%	31.71%	7.18%	4.41%	9.95%
Cox	4.19%	0.42%	2.96%	5.41%	-0.43%	-1.66%	0.79%
DirecTV	15.81%	0.77%	13.58%	18.03%	-3.96%	-6.18%	-1.73%
Dish Network	7.93%	0.57%	6.28%	9.57%	-6.01%	-7.66%	-4.36%
Mediacom	1.16%	0.23%	0.51%	1.81%	0.17%	-0.48%	0.82%
other	4.54%	0.44%	3.27%	5.81%	-2.81%	-4.08%	-1.54%
Suddenlink	1.11%	0.22%	0.47%	1.75%	-0.15%	-0.79%	0.49%
Time Warner	12.11%	0.69%	10.12%	14.10%	-0.01%	-2.00%	1.98%
Verizon	7.70%	0.56%	6.08%	9.33%	3.15%	1.52%	4.77%
Sequential	Number of samples:		2253.1				
AT&T	9.64%	0.62%	7.85%	11.44%	5.38%	3.58%	7.18%
Bright House	2.48%	0.33%	1.53%	3.43%	0.45%	-0.49%	1.40%
Cablevision	1.88%	0.29%	1.05%	2.71%	-1.35%	-2.18%	-0.52%
Charter	5.56%	0.48%	4.17%	6.96%	1.44%	0.04%	2.83%
Comcast	27.71%	0.94%	24.99%	30.44%	5.95%	3.23%	8.68%
Cox	4.69%	0.45%	3.40%	5.98%	0.07%	-1.21%	1.36%
DirecTV	14.77%	0.75%	12.61%	16.93%	-4.99%	-7.15%	-2.83%
Dish Network	8.39%	0.58%	6.71%	10.08%	-5.54%	-7.23%	-3.85%
Mediacom	0.75%	0.18%	0.22%	1.27%	-0.24%	-0.76%	0.28%
other	4.06%	0.42%	2.86%	5.27%	-3.29%	-4.49%	-2.09%
Suddenlink	0.78%	0.18%	0.24%	1.31%	-0.48%	-1.02%	0.05%
Time Warner	11.28%	0.67%	9.35%	13.21%	-0.84%	-2.77%	1.09%
Verizon	8.00%	0.57%	6.35%	9.65%	3.44%	1.79%	5.10%
Simultaneous	Number of samples:		2239.3				

AT&T	7.05%	0.54%	5.49%	8.61%	2.79%	1.22%	4.35%
Bright House	2.45%	0.33%	1.51%	3.40%	0.43%	-0.52%	1.38%
Cablevision	2.17%	0.31%	1.28%	3.07%	-1.06%	-1.95%	-0.16%
Charter	4.54%	0.44%	3.26%	5.81%	0.41%	-0.86%	1.68%
Comcast	28.94%	0.96%	26.17%	31.71%	7.18%	4.41%	9.95%
Cox	4.71%	0.45%	3.42%	6.01%	0.09%	-1.20%	1.39%
DirecTV	15.17%	0.76%	12.98%	17.36%	-4.60%	-6.79%	-2.41%
Dish Network	9.10%	0.61%	7.34%	10.85%	-4.84%	-6.60%	-3.08%
Mediacom	0.78%	0.19%	0.25%	1.32%	-0.20%	-0.74%	0.34%
other	5.83%	0.50%	4.40%	7.26%	-1.52%	-2.96%	-0.09%
Suddenlink	0.91%	0.20%	0.33%	1.49%	-0.35%	-0.93%	0.23%
Time Warner	11.55%	0.68%	9.60%	13.50%	-0.57%	-2.52%	1.38%
Verizon	6.79%	0.53%	5.26%	8.33%	2.24%	0.70%	3.78%

Table 35. Average numbers of TVs, overall and by demographic variable

Demographic category	Value	Average number	Standard error	Difference from RECS	Standard error	Lower 95% CI	Upper 95% CI
Non-weighted							
All Households	N/A	2.7234	0.0562	0.0668	0.0620	-0.0547	0.1884
Race	Other	2.8151	0.2541	0.1716	0.2850	-0.3870	0.7303
Race	White	2.7290	0.0646	0.0948	0.0710	-0.0443	0.2338
Race	Black	2.8218	0.1653	-0.0612	0.1822	-0.4183	0.2960
Race	Asian	2.3277	0.2119	0.0479	0.2503	-0.4427	0.5386
Income	$0 to $19,000	2.3030	0.1533	0.1258	0.1619	-0.1915	0.4432
Income	$20,000 to $39,000	2.5819	0.1046	0.1259	0.1159	-0.1013	0.3531
Income	$40,000 to $59,000	2.7760	0.1210	0.1058	0.1350	-0.1589	0.3705
Income	$60,000 to $79,000	2.7548	0.1671	0.0402	0.1857	-0.3237	0.4042
Income	$80,000 to $99,000	2.9071	0.1697	-0.0055	0.1885	-0.3749	0.3638
Income	$100,000 and more	3.0201	0.1689	-0.1403	0.1835	-0.4999	0.2193
Hispanic	Hispanic	2.7368	0.2357	0.0622	0.2471	-0.4222	0.5465
Hispanic	Non-Hispanic	2.7242	0.0584	0.0701	0.0648	-0.0569	0.1972
Gender	Female	2.7906	0.0846	0.1304	0.0919	-0.0498	0.3106
Gender	Male	2.6667	0.0750	0.0142	0.0843	-0.1510	0.1795
Geographic Region	New England	2.5636	0.2389	0.0127	0.2642	-0.5051	0.5306
Geographic Region	Middle Atlantic	2.8171	0.1498	0.2116	0.1647	-0.1111	0.5344
Geographic Region	East North Central	2.8669	0.1531	0.0784	0.1684	-0.2516	0.4085
Geographic Region	West North Central	2.7174	0.2217	0.0320	0.2442	-0.4467	0.5106
Geographic Region	South Atlantic	2.7992	0.1209	0.0514	0.1350	-0.2132	0.3159
Geographic Region	East South Central	2.7762	0.2209	0.1142	0.2444	-0.3649	0.5932
Geographic Region	West South Central	2.7871	0.1905	0.1254	0.2066	-0.2795	0.5304
Geographic Region	Mountain North	2.3968	0.2956	-0.2923	0.3310	-0.9410	0.3565
Geographic Region	Mountain South	2.6571	0.3167	0.0192	0.3479	-0.6626	0.7011
Geographic Region	Pacific	2.4629	0.1314	0.0027	0.1460	-0.2835	0.2889

Education	No Education	2.9048	0.5782	0.4961	0.5831	-0.6467	1.6389
Education	High School or GED	2.9311	0.1372	0.2863	0.1461	-0.0001	0.5727
Education	Some College	2.7564	0.1080	0.0115	0.1223	-0.2282	0.2512
Education	Associate Degree	2.9372	0.1904	0.2064	0.2089	-0.2030	0.6159
Education	Bachelor Degree	2.5649	0.0980	-0.1345	0.1147	-0.3593	0.0904
Education	Master Degree	2.5118	0.1736	-0.1026	0.1963	-0.4874	0.2823
Education	PhD or Professional Degree	2.5352	0.3004	0.0511	0.3347	-0.6049	0.7072
Ages of People in the Household	Less than 20	3.0682	0.0917	-0.0411	0.1038	-0.2445	0.1623
Ages of People in the Household	20 to 29	2.6952	0.0742	-0.0941	0.0947	-0.2797	0.0916
Ages of People in the Household	30 to 59	2.9212	0.0748	0.0929	0.0821	-0.0679	0.2537
Ages of People in the Household	60 or Greater	3.0833	0.1304	0.5567	0.1371	0.2880	0.8254
Size of the Household	1	1.8277	0.1107	-0.1140	0.1171	-0.3435	0.1155
Size of the Household	2	2.3017	0.0836	-0.2562	0.0941	-0.4406	-0.0718
Size of the Household	3	2.8615	0.1176	-0.0669	0.1363	-0.3339	0.2002
Size of the Household	4	3.1946	0.1417	-0.0326	0.1625	-0.3510	0.2859
Size of the Household	5	3.4787	0.2196	0.1730	0.2493	-0.3155	0.6616
Size of the Household	6 or More	3.4696	0.2966	-0.0810	0.3343	-0.7362	0.5741
Sequential							
All Households	N/A	2.6803	0.0556	0.0237	0.0615	-0.0969	0.1442
Race	Other	2.8795	0.2947	0.2361	0.3218	-0.3946	0.8667
Race	White	2.7004	0.0631	0.0662	0.0696	-0.0702	0.2026
Race	Black	2.6283	0.1550	-0.2547	0.1729	-0.5936	0.0842
Race	Asian	2.2383	0.2641	-0.0415	0.2958	-0.6213	0.5382
Income	$0 to $19,000	2.1333	0.1266	-0.0438	0.1369	-0.3121	0.2245
Income	$20,000 to $39,000	2.6764	0.1024	0.2204	0.1140	-0.0030	0.4438
Income	$40,000 to $59,000	2.7555	0.1371	0.0853	0.1496	-0.2079	0.3784

Income	$60,000 to $79,000	2.7598	0.1988	0.0452	0.2147	-0.3756	0.4660
Income	$80,000 to $99,000	2.7619	0.1690	-0.1507	0.1879	-0.5190	0.2175
Income	$100,000 and more	3.0387	0.1507	-0.1216	0.1668	-0.4486	0.2054
Hispanic	Hispanic	3.0334	0.1681	0.3587	0.1838	-0.0015	0.7188
Hispanic	Non-Hispanic	2.6338	0.0589	-0.0202	0.0653	-0.1482	0.1077
Gender	Female	2.7250	0.0777	0.0648	0.0856	-0.1030	0.2326
Gender	Male	2.6295	0.0794	-0.0229	0.0882	-0.1958	0.1501
Geographic Region	New England	2.5162	0.2281	-0.0347	0.2545	-0.5335	0.4641
Geographic Region	Middle Atlantic	2.6486	0.1427	0.0431	0.1583	-0.2671	0.3533
Geographic Region	East North Central	2.7464	0.1402	-0.0421	0.1568	-0.3494	0.2652
Geographic Region	West North Central	2.8130	0.2188	0.1276	0.2416	-0.3461	0.6012
Geographic Region	South Atlantic	2.6693	0.1248	-0.0786	0.1385	-0.3500	0.1929
Geographic Region	East South Central	2.6528	0.2100	-0.0093	0.2346	-0.4690	0.4505
Geographic Region	West South Central	3.2334	0.1938	0.5717	0.2097	0.1608	0.9827
Geographic Region	Mountain North	2.5281	0.3766	-0.1610	0.4050	-0.9548	0.6328
Geographic Region	Mountain South	2.6575	0.2590	0.0196	0.2963	-0.5611	0.6003
Geographic Region	Pacific	2.3438	0.1254	-0.1163	0.1407	-0.3920	0.1594
Education	No Education	3.1443	0.1648	0.7356	0.1812	0.3805	1.0908
Education	High School or GED	2.7027	0.1083	0.0579	0.1194	-0.1760	0.2919
Education	Some College	2.6529	0.1190	-0.0920	0.1321	-0.3509	0.1670
Education	Associate Degree	2.7905	0.1840	0.0597	0.2030	-0.3382	0.4577
Education	Bachelor Degree	2.5113	0.1183	-0.1880	0.1325	-0.4477	0.0716
Education	Master Degree	2.4436	0.1788	-0.1708	0.2009	-0.5646	0.2230
Education	PhD or Professional Degree	2.5084	0.3094	0.0244	0.3429	-0.6476	0.6963
Ages of People in the Household	Less than 20	3.1519	0.1016	0.0426	0.1126	-0.1782	0.2633
Ages of People in the Household	20 to 29	2.6639	0.1125	-0.1254	0.1269	-0.3742	0.1234
Ages of People in the Household	30 to 59	2.7629	0.0682	-0.0654	0.0760	-0.2145	0.0836

Ages of People in the Household	60 or Greater	2.9541	0.0993	0.4275	0.1079	0.2160	0.6389
Size of the Household	1	1.8635	0.0737	-0.0782	0.0829	-0.2408	0.0844
Size of the Household	2	2.5341	0.0910	-0.0238	0.1008	-0.2214	0.1737
Size of the Household	3	3.1388	0.1467	0.2104	0.1621	-0.1072	0.5280
Size of the Household	4	3.2463	0.1669	0.0191	0.1849	-0.3433	0.3814
Size of the Household	5	3.4412	0.2531	0.1355	0.2792	-0.4116	0.6827
Size of the Household	6 or More	3.6031	0.3240	0.0525	0.3589	-0.6509	0.7558
Simultaneous							
All Households	N/A	2.5810	0.0537	-0.0756	0.0598	-0.1928	0.0417
Race	Other	2.8452	0.2259	0.2017	0.2602	-0.3082	0.7116
Race	White	2.5867	0.0624	-0.0474	0.0690	-0.1826	0.0878
Race	Black	2.4790	0.1411	-0.4040	0.1606	-0.7187	-0.0893
Race	Asian	2.2669	0.2633	-0.0129	0.2951	-0.5914	0.5655
Income	$0 to $19,000	2.1427	0.1303	-0.0345	0.1403	-0.3096	0.2405
Income	$20,000 to $39,000	2.4514	0.0946	-0.0046	0.1070	-0.2144	0.2051
Income	$40,000 to $59,000	2.6494	0.1174	-0.0208	0.1318	-0.2791	0.2374
Income	$60,000 to $79,000	2.7531	0.1696	0.0385	0.1880	-0.3299	0.4069
Income	$80,000 to $99,000	2.7002	0.1690	-0.2124	0.1879	-0.5806	0.1559
Income	$100,000 and more	3.0328	0.1960	-0.1276	0.2087	-0.5366	0.2814
Hispanic	Hispanic	2.7361	0.1692	0.0614	0.1848	-0.3007	0.4236
Hispanic	Non-Hispanic	2.5620	0.0570	-0.0921	0.0636	-0.2167	0.0326
Gender	Female	2.5970	0.0769	-0.0632	0.0849	-0.2297	0.1033
Gender	Male	2.5654	0.0750	-0.0870	0.0843	-0.2523	0.0782
Geographic Region	New England	2.5327	0.2450	-0.0182	0.2697	-0.5468	0.5104
Geographic Region	Middle Atlantic	2.6503	0.1487	0.0448	0.1637	-0.2760	0.3656
Geographic Region	East North Central	2.5204	0.1366	-0.2681	0.1535	-0.5690	0.0328
Geographic Region	West North Central	2.4652	0.1873	-0.2202	0.2136	-0.6388	0.1983
Geographic Region	South Atlantic	2.5822	0.1195	-0.1656	0.1337	-0.4276	0.0964
Geographic Region	East South Central	2.6156	0.1996	-0.0464	0.2254	-0.4881	0.3952

Geographic Region	West South Central	2.7747	0.1677	0.1131	0.1858	-0.2512	0.4773
Geographic Region	Mountain North	2.7877	0.2607	0.0986	0.3003	-0.4899	0.6871
Geographic Region	Mountain South	2.5587	0.3962	-0.0792	0.4215	-0.9054	0.7469
Geographic Region	Pacific	2.4227	0.1311	-0.0375	0.1458	-0.3232	0.2482
Education	No Education	2.8128	0.4737	0.4042	0.4797	-0.5359	1.3442
Education	High School or GED	2.6283	0.1044	-0.0165	0.1158	-0.2435	0.2105
Education	Some College	2.6018	0.1087	-0.1431	0.1230	-0.3842	0.0979
Education	Associate Degree	2.7704	0.1891	0.0397	0.2077	-0.3674	0.4467
Education	Bachelor Degree	2.4499	0.1020	-0.2494	0.1182	-0.4811	-0.0178
Education	Master Degree	2.5917	0.1859	-0.0227	0.2073	-0.4291	0.3837
Education	PhD or Professional Degree	2.3076	0.2691	-0.1765	0.3069	-0.7780	0.4251
Ages of People in the Household	Less than 20	2.9716	0.0941	-0.1377	0.1059	-0.3453	0.0698
Ages of People in the Household	20 to 29	2.7873	0.1112	-0.0020	0.1258	-0.2485	0.2445
Ages of People in the Household	30 to 59	2.6465	0.0630	-0.1818	0.0714	-0.3218	-0.0419
Ages of People in the Household	60 or Greater	2.7928	0.1161	0.2662	0.1236	0.0239	0.5084
Size of the Household	1	1.9506	0.0793	0.0089	0.0880	-0.1636	0.1814
Size of the Household	2	2.4126	0.0859	-0.1454	0.0961	-0.3338	0.0430
Size of the Household	3	2.8696	0.1421	-0.0588	0.1579	-0.3682	0.2506
Size of the Household	4	3.1762	0.1667	-0.0509	0.1847	-0.4130	0.3111
Size of the Household	5	3.5159	0.2439	0.2103	0.2709	-0.3207	0.7413
Size of the Household	6 or More	3.2638	0.3423	-0.2868	0.3754	-1.0226	0.4490

9.3 Deployed survey instruments

9.3.1 RP survey

Refrigeration Products Survey

Qualifications: U.S. residents at least 18 years old.

Please answer honestly and accurately! We have provided plenty of time for you to answer every question carefully.

NOTE: You will NOT GET PAID if you do not qualify for this survey or answer all questions that you are NOT asked to skip. Also, due to the size of our research study, we may take up to 21 DAYS to pay you.

Refrigerators

If you live in more than one home, please restrict your responses to the home you use the most.

1. A ***refrigerator*** cools items such as food to a temperature below 39°F (4°C). It may include a separate freezer or wine/beverage cooler compartment.

How many refrigerators are plugged in at your home right now?

DO NOT INCLUDE:

- stand-alone freezers
- stand-alone wine/beverage coolers

INCLUDE:

- **full-size refrigerators (example)**
- **compact refrigerators (example)**
- **refrigerators with separate freezers or wine/beverage cooler compartments (example)**

Check the number of refrigerators

- None
- 1
- 2
- 3

- 4
- 5 or more
- Don't know

If you answered "None" to the above question, please skip to Question 16.

2. Some refrigerators have a special section or compartment specifically designed to store wine at a temperature warmer than 39°F (4°C). This is different than a wine shelf or rack that comes with some standard refrigerators that is maintained at the same temperature as the rest of the compartment.

Do you have a refrigerator with a SPECIAL SECTION OR COMPARTMENT designed specifically for storing wine at a warmer temperature?

- Yes
- No
- Don't know

If you answered "No" or "Don't know" to the above question, please skip to Question 4.

3. How many full-sized (750 mL) bottles of wine is this refrigerator's wine storage section able to hold? [Drop-down menu]

- Up to 5 bottles
- Between 6 and 10 bottles
- Between 11 and 15 bottles
- Between 16 and 20 bottles
- Between 21 and 25 bottles
- Between 26 and 30 bottles
- 31 or more bottles
- Don't know

4. Most refrigeration products found in homes operate only on alternating current (AC) electricity, which is the normal type of 120-volt power found in standard electrical outlets. However, some refrigeration products can operate on either AC electricity or direct current (DC) electricity, which is the type of power that can be supplied by a battery.

Do you have a refrigerator that can operate on either AC or DC electricity?

- Yes
- No
- Don't know

5. Most refrigeration products use vapor compression technology to keep foods and beverages cold. But some refrigeration products are cooled with other types of technologies. One technology is called thermoelectric cooling and another is called absorption cooling . Both are quieter than regular refrigeration technology and produce little vibration. Also, absorption cooling can be powered by propane or some other fuel as well as by electricity. Common brands featuring these technologies include EdgeStar and Dometic.

Do you have a *refrigerator* that uses THERMOELECTRIC or ABSORPTION COOLING technology to provide cooling?

DO NOT INCLUDE:

- stand-alone freezers
- stand-alone wine/beverage coolers

INCLUDE:

- **Refrigerators**
- **Refrigerators with freezer compartments**
- **Refrigerators with wine/beverage cooler section or compartment**

Indicate if you have any refrigerators that use thermoelectric or absorption cooling.

- Yes
- No
- Don't know

If you answered "No" or "Don't know" to the above question, please skip to Question 16.

*If you have more than one thermoelectric or absorption cooling refrigerator in your home, please restrict your answers below to the **largest-capacity** unit.*

The next three questions ask for the brand and model number of this refrigerator. You can often find this information on the product "nameplate," which is a small rectangular label usually located inside or on the back of the refrigerator. Your owner's manual will also provide you with the brand and model number.

6. What is the brand of this refrigerator? [Drop-down menu]

- Amana
- Avanti Pro
- Bon Jour
- Bosch
- Cuisinart
- Dacor
- Danby
- Dometic
- EdgeStar
- Electrolux
- Emerson
- Franklin
- Frigidaire
- GE
- Haier
- Igloo
- JennAir
- Kalorik
- KitchenAid
- Liebherr
- Magic Chef
- Marvel
- Miele
- Sanyo
- Scotsman
- Sub-Zero
- Summit
- Sunbeam
- Thermador
- Tresanti

- Uline
- Viking
- Vinotemp
- Whirlpool
- Whynter
- Wine Enthusiast
- Other
- Don’t know/Decline to state

If you answered “Other” to the above question, please answer Question 7. Otherwise, please skip to Question 8.

7. Please enter the brand name of this refrigerator:

8. What is the full model number of this refrigerator? If you don't know, please skip this question.

Please enter model number:

9. Please indicate which cooling technology this refrigerator uses:

- Thermoelectric
- Absorption cooling
- Don’t know

If you answered “Thermoelectric” or “Don’t know” to the above question, please skip to Question 11.

10. Can your ABSORPTION COOLING refrigerator operate with propane as well as electricity?

- Yes
- No
- Don’t know

11. The capacity of a refrigerator is normally listed on the “nameplate,” which as mentioned above is a small rectangular label usually located inside or on the back of the unit. You can also find this information in the owner’s manual.

Please estimate the total capacity of this THERMOELECTRIC or ABSORPTION COOLING refrigerator: [Drop-down menu; *note that the metric conversions were incorrect in this question*]

- ○ Up to 7.75 cubic feet (30 liters, sometimes called "compact")
- ○ More than 7.75 but less than 12 cubic feet (31 to 46 liters)
- ○ More than 12 but less than 16 cubic feet (47 to 61 liters)
- ○ More than 16 but less than 20 cubic feet (62 to 77 liters)
- ○ More than 20 but less than 24 cubic feet (78 to 92 liters)
- ○ More than 24 but less than 28 cubic feet (93 to 108 liters)
- ○ More than 28 cubic feet (109 or more liters)
- ○ Don't know

12. Does this refrigerator contain a SEPARATE freezer section?

- ○ Yes
- ○ No
- ○ Don't know

If you answered "No" or "Don't know" to the above question, please skip to Question 14.

13. Please estimate the capacity of the freezer section of this refrigerator: [Drop-down menu; *note that the metric conversions were incorrect in this question*]

- ○ Less than half of a cubic foot (enough for ice trays only)
- ○ At least half of a cubic foot but less than 2 cubic feet (2 to 7 liters)
- ○ At least 2 cubic feet but less than 4 cubic feet (8 to 15 liters)
- ○ At least 4 cubic feet but less than 8 cubic feet (16 to 30 liters)
- ○ At least 8 cubic feet but less than 12 cubic feet (31 to 46 liters)
- ○ At least 12 cubic feet but less than 16 cubic feet (47 to 61 liters)
- ○ At least 16 cubic feet (62 or more liters)
- ○ Don't know

14. Does this THERMOELECTRIC or ABSORPTION COOLING refrigerator have a separate section or compartment designed specifically for storing wine at a warmer temperature?

- Yes
- No
- Don't know

If you answered "No" or "Don't know" to the above question, please skip to Question 16.

15. How many full-sized (750 mL) bottles of wine is this refrigerator's wine storage section able to hold? [Drop-down menu]

- Up to 5 bottles
- Between 6 and 10 bottles
- Between 11 and 15 bottles
- Between 16 and 20 bottles
- Between 21 and 25 bottles
- Between 26 and 30 bottles
- 31 or more bottles
- Don't know

16. What material are wine bottles typically made from?

- Fabric
- Glass
- Rubber
- Tile
- Wood
- Don't know

Freezers

17. A ***freezer*** freezes and stores items such as food at 0°F (–18°C) or below. It may include a separate wine/beverage cooler compartment.

How many <u>stand-alone freezers</u> are plugged in at your home right now?

DO <u>NOT</u> INCLUDE:

- freezers that are part of refrigerators

- stand-alone wine/beverage coolers
- stand-alone refrigerators

INCLUDE:

- **stand-alone, full-size freezers (example)**
- **stand-alone, compact freezers (example)**
- **freezers with separate wine/beverage cooler section or compartment**

Check the number of stand-alone freezers

- ○ None
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5 or more
- ○ Don't know

If you answered "None" to the above question, please skip to Question 30.

18. Do you have a freezer with a SEPARATE SECTION OR COMPARTMENT designed specifically for storing wine at a temperature higher than 39°F (4°C)?

- ○ Yes
- ○ No
- ○ Don't know

If you answered "No" or "Don't know" to the above question, please skip to Question 20.

19. How many full-sized (750 mL) bottles of wine is this freezer's wine storage section able to hold? [Drop-down menu]

- ○ Up to 5 bottles
- ○ Between 6 and 10 bottles
- ○ Between 11 and 15 bottles
- ○ Between 16 and 20 bottles
- ○ Between 21 and 25 bottles

- Between 26 and 30 bottles
- 31 or more bottles
- Don't know

20. Most refrigeration products found in homes operate only on alternating current (AC) electricity, which is the normal type of 120-volt power found in standard electrical outlets. However, some refrigeration products can operate on either AC electricity or direct current (DC) electricity, which is the type of power that can be supplied by a battery.

Do you have a freezer that can operate on either AC or DC electricity?

- Yes
- No
- Don't know

21. Most refrigeration products use vapor compression technology to keep foods and beverages cold. But some refrigeration products are cooled with other types of technologies. One technology is called thermoelectric cooling and another is called absorption cooling. Both are quieter than regular refrigeration technology and produce little vibration. Also, absorption cooling can be powered by propane or some other fuel as well as by electricity. Common brands featuring these technologies include EdgeStar and Dometic.

Do you have a <u>freezer</u> that uses THERMOELECTRIC or ABSORPTION COOLING technology to provide cooling?

DO <u>NOT</u> INCLUDE:

- Refrigerators
- Refrigerators with a separate freezer compartment
- Stand-alone wine/beverage coolers

INCLUDE:

- **Stand-alone freezers**
- **Freezers with a wine/beverage cooler section or compartment**

Indicate if you have any <u>freezers</u> that use thermoelectric or absorption cooling.

- Yes
- No
- Don't know

If you answered "No" or "Don't' know" to the above question, please skip to Question 30.

*If you have more than one thermoelectric or absorption cooling freezer in your home, please restrict your answers below to your **largest-capacity** unit.*

The next three questions ask for the brand and model number of this freezer. You can often find this information on the product "nameplate," which is a small rectangular label usually located inside or on the back of the freezer. Your owner's manual will also provide you with the brand and model number.

22. What is the brand of this freezer? [Drop-down menu]

- Amana
- Avanti Pro
- Bon Jour
- Bosch
- Cuisinart
- Dacor
- Danby
- Dometic
- EdgeStar
- Electrolux
- Emerson
- Franklin
- Frigidaire
- GE
- Haier
- Igloo
- JennAir
- Kalorik
- KitchenAid
- Liebherr
- Magic Chef
- Marvel

- Miele
- Sanyo
- Scotsman
- Sub-Zero
- Summit
- Sunbeam
- Thermador
- Tresanti
- Uline
- Viking
- Vinotemp
- Whirlpool
- Whynter
- Wine Enthusiast
- Other
- Don’t know/Decline to state

If you answered “Other” to the above question, please answer Question 23. Otherwise, please skip to Question 24.

23. Please enter the brand name of this freezer:

24. What is the full model number of this freezer? If you don't know, please skip this question.

Please enter model number:

25. Please indicate which cooling technology this freezer uses:

- Thermoelectric
- Absorption cooling
- Don’t know

If you answered “Thermoelectric” or “Don’t know” to the above question, please skip to question 27.

26. Can your ABSORPTION COOLING freezer operate with propane as well as electricity?

- Yes
- No
- Don't know

27. The capacity of a freezer is normally listed on the "nameplate," which as mentioned above is a small rectangular label usually located inside or on the back of the unit. You can also find this information in the owner's manual.

Please estimate the total capacity of this THERMOELECTRIC or ABSORPTION COOLING freezer: [Drop-down menu]

- Up to 7.75 cubic feet (30 liters, sometimes called "compact")
- More than 7.75 but less than 12 cubic feet (31 to 46 liters)
- More than 12 but less than 16 cubic feet (47 to 61 liters)
- More than 16 but less than 20 cubic feet (62 to 77 liters)
- More than 20 but less than 24 cubic feet (78 to 92 liters)
- More than 24 but less than 28 cubic feet (93 to 108 liters)
- More than 28 cubic feet (109 or more liters)
- Don't know

28. Does this THERMOELECTRIC or ABSORPTION COOLING freezer have a separate section or compartment designed specifically for storing wine at a warmer temperature?

- Yes
- No
- Don't know

If you answered "No" or "Don't know" to the above question, please skip to Question 30.

29. How many full-sized (750 mL) bottles of wine is this freezer's wine storage section able to hold? [Drop-down menu]

- Up to 5 bottles
- Between 6 and 10 bottles

- Between 11 and 15 bottles
- Between 16 and 20 bottles
- Between 21 and 25 bottles
- Between 26 and 30 bottles
- 31 or more bottles
- Don't know

Wine/beverage coolers

30. How many bottles of wine are there in a dozen? [Drop-down menu]

- 1
- 2
- 6
- 12
- 24
- 50 or more
- Don't know

31. A ***wine chiller, wine cooler, beverage cooler or beverage center*** are special types of appliances used mainly for cooling liquids such as wine, at 39° to 65°F (4° to 18°C). We say "wine/beverage cooler" to describe these appliances.

How many stand-alone, wine/beverage coolers are plugged in at your home right now?

DO NOT INCLUDE:

- refrigerators
- freezers
- refrigerators or freezers with a wine/beverage cooler section or compartment

INCLUDE:

- **stand-alone, full-size wine/beverage coolers (example)**
- **stand-alone, compact wine/beverage coolers (example)**

Check the number of stand-alone wine/beverage coolers

- None

- 1
- 2
- 3
- 4
- 5 or more
- Don't know

If you answered "None" to the above question, please skip to Question 36.

32. Most refrigeration products found in homes operate only on alternating current (AC) electricity, which is the normal type of 120-volt power found in standard electrical outlets. However, some refrigeration products can operate on either AC electricity or direct current (DC) electricity, which is the type of power that can be supplied by a battery.

Do you have a wine/beverage cooler that can operate on either AC or DC electricity?

- Yes
- No
- Don't know

33. Most refrigeration products use vapor compression technology to keep foods and beverages cold. But some refrigeration products are cooled with other types of technologies. One technology is called thermoelectric cooling and another is called absorption cooling. Both are quieter than regular refrigeration technology and produce little vibration. Also, absorption cooling can be powered by propane or some other fuel as well as by electricity. Common brands featuring these technologies include EdgeStar and Dometic.

Do you have a *wine/beverage cooler* that uses THERMOELECTRIC or ABSORPTION COOLING technology to provide cooling?

DO NOT INCLUDE:

- Refrigerators
- Freezers
- Refrigerators or freezers with a wine/beverage cooler section or compartment"

INCLUDE:

- **Stand-alone wine/beverage coolers**

Indicate if you have any <u>wine/beverage coolers</u> that use thermoelectric or absorption cooling.

- ○ Yes
- ○ No
- ○ Don't know

If you answered "No" or "Don't know" to the above question, please skip to Question 36.

*If you have more than one thermoelectric or absorption cooling wine/beverage cooler in your home, please restrict your answers below to your **largest-capacity** unit.*

34. Please indicate which cooling technology this wine/beverage cooler uses:

- ○ Thermoelectric
- ○ Absorption cooling
- ○ Don't know

If you answered "Thermoelectric" or "Don't know" to the above question, please skip to Question 36.

35. Can your ABSORPTION COOLING wine/beverage cooler operate with propane as well as electricity?

- ○ Yes
- ○ No
- ○ Don't know

Icemakers

36. An icemaker automatically produces ice (usually in small cubes) and keeps them frozen for later use. It is often included in a refrigerator or freezer, but some icemakers are completely separate from a standard refrigerator or freezer and are called "stand-alone icemakers."

How <u>many stand-alone icemakers</u> are plugged in at your home right now?

DO <u>NOT</u> INCLUDE:

- refrigerators
- freezers
- wine/beverage coolers

- icemakers that are part of a refrigerator or freezer

INCLUDE:

- **stand-alone icemakers (example)**

Check the number of stand-alone icemakers

- None
- 1
- 2
- 3
- 4
- 5 or more
- Don't know

If you answered "None" to the above question, please skip to Question 38.

37. How many pounds of ice can your stand-alone icemaker make per day?

- Less than 10 pounds per day
- Between 10 and 19 pounds per day
- Between 20 and 29 pounds per day
- Between 30 and 49 pounds per day
- Between 50 and 79 pounds per day
- At least 80 pounds per day
- Don't know

38. Who is the current president of the U.S.? [Drop-down menu]

- Amana
- Bosch
- Emerson
- Franklin
- GE

- KitchenAid
- Obama
- Scotsman
- Tresanti
- Don’t know

Demographics

39. What is your zip code?

40. What is your gender?

- Female
- Male
- Decline to state

41. Are you Hispanic or Latino?

- Yes
- No
- Decline to state

42. What is your race? Please check all that apply:

- American Indian or Alaska Native
- Asian
- Black or African American
- Native Hawaiian or Other Pacific Islander
- White or Caucasian
- other
- Decline to state

43. What is your highest education level?

- No schooling completed

- Kindergarten to grade 12 (No Diploma)
- High school diploma or GED
- Some college, no degree
- Associate's degree (for example: AA, AS)
- Bachelor's degree (for example: BA, BS)
- Master's degree (for example: MA, MS, MBA)
- Professional degree (for example: MD, JD)
- Doctorate degree (for example: PhD, EdD)
- Decline to state

44. How many people live in your home for most of the year (including you)?

Number of people

1 2 3 4 5 6 7 8 9

10 or more Doesn't apply

45. Of the people you included in the total for Question 44, how many people are in the following age categories (please fill in the number of people for all applicable categories)

Younger than 20

1 2 3 4 5 6 7 8 9

10 or more Doesn't apply

20 to 29 years old

1 2 3 4 5 6 7 8 9

10 or more Doesn't apply

30 to 39 years old

1 2 3 4 5 6 7 8 9

10 or more Doesn't apply

40 to 49 years old

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9

○ 10 or more ○ Doesn't apply

50 to 59 years old

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9

○ 10 or more ○ Doesn't apply

60 to 69 years old

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9

○ 10 or more ○ Doesn't apply

70 or older

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9

○ 10 or more ○ Doesn't apply

Age unknown

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9

○ 10 or more ○ Doesn't apply

46. What is your combined annual household income?

- ○ $0-$19,999 per year
- ○ $20,000-$39,999 per year
- ○ $40,000-$59,999 per year
- ○ $60,000-$79,999 per year
- ○ $80,000-$99,999 per year
- ○ $100,000-$119,999 per year

- $120,000-$149,999 per year
- $150,000-$199,999 per year
- $200,000 or more per year
- Don’t know/Decline to state

47. What type of home do you live in most of the year?

- single-family house
- multi-family apartment building
- mobile or manufactured home
- dormitory
- something else
- don't know

Due to the size of our research study, we may take up to 21 DAYS to pay you.

9.3.2 TS survey

Household Television and Set-Top Box Questionnaire

To participate in this survey, you must:

- Be 18 year or older
- Be the head of the household
- Be the person most responsible for consumer electronics purchases
- Own a set-top box that is connected to a TV

NOTE: You will NOT GET PAID If you do not qualify for this survey or If you do not answer all questions that you are NOT asked to skip. Also, due to the size of our research study, we may take up to 21 DAYS to pay you.

If you do not fulfill the above criteria, you cannot participate and will not be paid.

S1.
Are you the male or female head of the household?

- ○ Male head of the household
- ○ Female head of the household
- ○ Female, not head of the household
- ○ Male, not head of the household

If you did not indicate that you are head of the household for S1 above, please do not proceed with survey. Thank you.

S2.
What is your age? [Drop-down menu]

- ○ Under 18
- ○ 18
- ○ 19
- ○ 20
- ○ 21
- ○ 22
- ○ 23

- 24
- 25
- 26
- 27
- 28
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- 91
- 92
- 93
- 94
- 95
- 96
- 97
- 98
- 99
- Prefer not to say

If you answered "Under 18" or "Prefer not to say" in the above question, please do not proceed with survey. Thank you.

S3.
In which state is your primary residence? [Drop-down menu]

- Alabama
- Alaska
- Arizona
- Arkansas
- California
- Colorado
- Connecticut
- Delaware
- District of Columbia

- Florida
- Georgia
- Hawaii
- Idaho
- Illinois
- Indiana
- Iowa
- Kansas
- Kentucky
- Louisiana
- Maine
- Maryland
- Massachusetts
- Michigan
- Minnesota
- Mississippi
- Missouri
- Montana
- Nebraska
- Nevada
- New Hampshire
- New Jersey
- New Mexico
- New York
- North Carolina
- North Dakota
- Ohio
- Oklahoma
- Oregon
- Pennsylvania

- Rhode Island
- South Carolina
- South Dakota
- Tennessee
- Texas
- Utah
- Vermont
- Virginia
- Washington
- West Virginia
- Wisconsin
- Wyoming

S4.

What is your five-digit ZIP code?

S5.
When it comes to each of the following types of shopping, who in your household is most responsible for the products and brands purchased?

S5-A. Groceries for daily household needs, such as food, beverages, and cleaning supplies. **[Drop-down menu]**

- I am
- My spouse/partner
- It is a shared responsibility between me and my spouse/partner

S5-B. Consumer electronics, such as digital cameras, smartphones, and TVs **[Drop-down menu]**

- I am
- My spouse/partner
- It is a shared responsibility between me and my spouse/partner

S5-C. Kitchen appliances, such as mixers, food processors, and coffee makers **[Drop-down menu]**

- I am
- My spouse/partner
- It is a shared responsibility between me and my spouse/partner

If you did not answer "I am" for S5-B ["Consumer Electronics"], please do not proceed with survey. Thank you.

S6.
How many TVs (in working order) does your household own?

- None
- 1
- 2
- 3
- 4
- 5+
- Don't know

If you answered "None" or "Don't know" in the above question, please do not proceed with survey. Thank you.

DEFINITION
A Set-Top Box (STB) connects to your TV and its main function is to allow you to receive video content from your television service provider (e.g., Comcast, DirecTV, AT&T U-Verse) and/or the internet (e.g., Netflix, Hulu, iTunes). STBs associated with television service providers are called pay-TV STBs. A standalone DVR (digital video recorder), such as a TiVo, also counts as a set-top box.

S7.
How many Set-Top Boxes (in working order) does your household own?

- None
- 1
- 2
- 3
- 4
- 5+

- Don’t know

If you answered “0” or “Don’t know” in the above question, please do not proceed with survey. Thank you.

S8.
How many TV screens do you have in your home that are connected to Set-Top Boxes?

- 0
- 1
- 2
- 3
- 4
- 5+
- Don’t know

***Set-Top Boxes*.....**

Q1.
Do you subscribe to content from a TV Service Provider (e.g. Cable, Satellite, Fiber Optic)?

- Yes
- No
- Don’t know

If you did not answer “Yes” in the above question, please skip to Q9.

Q2.
Who is your primary subscription TV service provider? [Drop-down menu]

- AT&T
- AT&T U-Verse
- Bright House Networks
- Cablevision
- Charter Communications
- Comcast

- Cox Communications
- DirecTV
- Dish Network
- Insight Communications
- Mediacom
- Suddenlink
- Time Warner
- Verizon
- Verizon FiOS
- Other
- Don’t know

Q2b.
Who is the current president of the United States? [Drop-down menu]

- AT&T
- AT&T U-Verse
- Bright House Networks
- Cablevision
- Charter Communications
- Comcast
- Cox Communications
- DirecTV
- Dish Network
- Insight Communications
- Mediacom
- Suddenlink
- Time Warner
- Verizon
- Verizon FiOS
- Other

- Don’t know

Q3.
How recently did you begin service with your primary subscription TV service provider?

- Less than 12 months ago
- At least 1 but less than 2 years ago
- At least 2 but less than 3 years ago
- At least 3 but less than 4 years ago
- At least 4 but less than 5 years ago
- At least 5 but less than 6 years ago
- At least 6 but less than 8 years ago
- At least 8 but less than 10 years ago
- At least 10 but less than 12 years ago
- At least 12 but less than 15 years ago
- 15+ years ago
- Don’t know

Q4.
How many times have you switched your primary subscription TV service provider in your current home?

- 0
- 1
- 2
- 3
- 4
- 5+
- Don’t know

Q5.
How many pay-TV Set-Top Boxes do you have in your house as part of your primary subscription TV service?

- 1

- 2
- 3
- 4
- 5+
- Don’t know

Q6.
How recently did you acquire your newest pay-TV Set-Top Box?

- Less than 12 months ago
- At least 1 but less than 2 years ago
- At least 2 but less than 3 years ago
- At least 3 but less than 4 years ago
- At least 4 but less than 5 years ago
- Five or more years ago
- Don’t know

Q7.
Was your newest pay-TV Set-Top Box

- A replacement of the same model Set-Top Box
- An upgrade of an older model Set-Top Box
- This is my first Set-Top Box with this service provider
- Don’t know

Q8.
Was your newest pay-TV Set-Top Box

- Free from your service provider
- Rented from your service provider
- Purchased in full from service provider
- Purchased from a retail store
- Don’t know

Q9.
Do you have a stand alone DVR (digital video recorder), such as a TiVo, to record TV content? Please do not include any pay-TV Set-Top Boxes with DVR capabilities that are part of your subscription TV service.

- Yes
- No
- Don't know

If you did not answer "Yes" in the above question, please skip to Q12.

Q10.
How many stand alone DVRs in total do you have in your house?

- 1
- 2
- 3
- 4
- 5+
- Don't know

Q11.
How recently did you acquire your newest standalone DVR? [Drop-down menu]

- Less than 12 months ago
- At least 1 but less than 2 years ago
- At least 2 but less than 3 years ago
- At least 3 but less than 4 years ago
- At least 4 but less than 5 years ago
- Five or more years ago
- Don't know

Q12.
How many days are there in a month?

- Less than 5 days

- At least 5 and less than 15 days
- At least 15 and less than 25 days
- At least 25 and less than 35 days
- At least 35 and less than 45 days
- At least 45 days
- Don't know

Q12b.
Do you have any stand alone Set-Top Boxes which stream internet content ONLY (e.g., Apple TV, Boxee, Roku, etc.)? Please do not include any game consoles or computers.

- Yes
- No
- Don't know

If you did not answer "Yes" in the above question, please skip to Q15.

Q13.
How many internet-only Set-Top Boxes in total do you have in your house?

- 1
- 2
- 3
- 4
- 5+
- Don't know

Q14.
How recently did you acquire your newest internet-only Set-Top Box? [Drop-down menu]

- Less than 12 months ago
- At least 1 but less than 2 years ago
- At least 2 but less than 3 years ago
- At least 3 but less than 4 years ago
- At least 4 but less than 5 years ago

- ○ Five or more years ago
- ○ Don't know

***Advanced Capabilities*.....**

Q15.
Thinking again about your primary pay-TV Set-Top Box that is part of your subscription TV service, which of the following features does it have?

- ☐ Built-in Digital Video Recorder (DVR) for recording and playback of TV content
- ☐ High-definition (HD) resolution (720p or greater)
- ☐ Multi-room capability (ability to provide audio/video content to multiple devices within a single home, or to pause content on one device and resume on another)
- ☐ Multi-stream capability (ability to deliver two or more simultaneous audio/video streams to a display, such as picture-in-picture or the ability to watch one program while recording another)
- ☐ DVD or Blu-Ray player/recorder
- ☐ Home network interface (capability of interfacing with external devices via a network, such as Wi-Fi. This includes watching content on mobile devices via your Set-Top Box)
- ☐ None of these
- ☐ Don't know

If you checked "HOME NETWORK INTERFACE" AT Q15, PLEASE ANSWER THE NEXT QUESTION; OTHERWISE SKIP TO Q17.

Q16.
On average, how many hours a day do you estimate you watch television content on mobile devices via your Set-Top Box?

- ○ Less than 1 hour
- ○ At least 1 but less than 2 hours
- ○ At least 2 but less than 3 hours
- ○ At least 3 but less than 4 hours
- ○ At least 4 but less than 6 hours
- ○ At least 6 but less than 8 hours
- ○ Eight or more hours
- ○ Don't know

***TV Watching Habits*.....**

Q17.
On an average WEEKDAY (Monday – Friday) which times of the day does anyone in your household watch television where at least one Set-Top Box is being used?

- ☐ Between Midnight and 2 AM
- ☐ Between 2 AM and 4 AM
- ☐ Between 4 AM and 6 AM
- ☐ Between 6 AM and 8 AM
- ☐ Between 8 AM and 10 AM
- ☐ Between 10 AM and 12 PM
- ☐ Between Noon and 2 PM
- ☐ Between 2 PM and 4 PM
- ☐ Between 4 PM and 6 PM
- ☐ Between 6 PM and 8 PM
- ☐ Between 8 PM and 10 PM
- ☐ Between 10 PM and Midnight
- ☐ None of these
- ☐ Don't know

Q18.
On an average WEEKEND (Saturday – Sunday) which times of the day does anyone in your household watch television where at least one Set-Top Box is being used?

- ☐ Between Midnight and 2 AM
- ☐ Between 2 AM and 4 AM
- ☐ Between 4 AM and 6 AM
- ☐ Between 6 AM and 8 AM
- ☐ Between 8 AM and 10 AM
- ☐ Between 10 AM and 12 PM
- ☐ Between Noon and 2 PM
- ☐ Between 2 PM and 4 PM
- ☐ Between 4 PM and 6 PM

- [ ] Between 6 PM and 8 PM
- [ ] Between 8 PM and 10 PM
- [ ] Between 10 PM and Midnight
- [ ] None of these
- [ ] Don’t know

Q19.
How many hours per day do you estimate that more than one TV is on AT THE SAME TIME in your household?

- ○ 0
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7-8
- ○ 9-10
- ○ 11-15
- ○ 16-20
- ○ 21-24
- ○ Don’t know

Q19b.
How many hours are there in a single day?

- ○ Less than 5 hours
- ○ 6 hours
- ○ 12 hours
- ○ 18 hours
- ○ 24 hours
- ○ 36 hours

- 48 hours or more
- Don't know

Set Top Box Usage**.....**

When your Set-Top Box is not being used, what do you normally do?

- Leave it on
- Turn it off via remote or console button
- Unplug it or turn off at power strip
- Don't know

DEFINITION
Many Set-Top Boxes have a standby mode feature. Putting a Set-Top Box in a standby mode when not in use may use significantly less energy, but requires a short boot-up time. Set-Top Boxes provide direct channel access within a few seconds of coming out of standby mode, but "full functionality" is typically not available immediately. "Full functionality" refers to the availability of special features, such as electronic program guides and video-on-demand.

Q21.
When coming out of standby mode during a time in which you typically watch TV, what is the longest delay that you would consider acceptable before the set-top box provides full functionality? [Drop-down menu]

- No delay at all
- One to Five seconds
- 15 seconds
- 30 seconds
- 60 seconds
- 1-2 minutes
- Don't know

Q22.
When coming out of standby mode during a time in which you typically do not watch TV, what is the longest delay that you would consider acceptable before the set-top box provides full functionality? [Drop-down menu]

- No delay at all

- One to Five seconds
- 15 seconds
- 30 seconds
- 60 seconds
- 1-2 minutes
- Don't know

Q23.
How soon after you are done watching TV or recording a program would you feel comfortable with your Set-Top Box automatically powering down and entering standby mode? [Drop-down menu]

- No delay at all
- One to Five seconds
- 15 seconds
- 30 seconds
- 60 seconds
- 1-2 minutes
- Don't know

Demographics**.....**

Q24a.
Are you of Hispanic or Latino origin or descent?

- Yes
- No
- Prefer not say

Q24b.
Are you…..

- White
- American Indian/Alaska Native
- Black/African-American

- Native Hawaiian/Other Pacific Islander
- Asian
- Two or more races
- Other
- Prefer not to say

Q25.
What is the highest level of education you have completed? [Drop-down menu]

- No schooling completed
- Kindergarten to grade 12 (No Diploma)
- High school diploma or GED
- Some college, no degree
- Associate's degree (for example: AA, AS)
- Bachelor's degree (for example: BA, BS)
- Master's degree (for example: MA, MS, MBA)
- Professional degree (for example: MD, JD)
- Doctorate degree (for example: PhD, EdD
- Decline to state

Q26.
How many persons live in your household for at least six months of the year? Please include yourself in that number.

Number of people

1 2 3 4 5 6 7 8 9 10 or more

Don't know/Decline to state Doesn't apply

Q27.
Including yourself, how many members are there who are…

Under 9 years old

1 2 3 4 5 6 7 8 9 10 or more

○ Don't know/Decline to state ○ Doesn't apply

10 to 19 years old

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10 or more

○ Don't know/Decline to state ○ Doesn't apply

20 to 29 years old

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10 or more

○ Don’t know/Decline to state ○ Doesn’t apply

30 to 39 years old

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10 or more

○ Don’t know/Decline to state ○ Doesn’t apply

40 to 49 years old

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10 or more

○ Don’t know/Decline to state ○ Doesn’t apply

50 to 59 years old

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10 or more

○ Don’t know/Decline to state ○ Doesn’t apply

60 to 69 years old

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10 or more

○ Don’t know/Decline to state ○ Doesn’t apply

70 or older

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10 or more

○ Don't know/Decline to state ○ Doesn't apply

Age unknown or Prefer not to say

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10 or more

○ Don't know/Decline to state ○ Doesn't apply

Q28.
Which of the following best describes the total yearly income of all members of your household before taxes?

- ○ Under $10,000 per year
- ○ $10,000 to $14,999 per year
- ○ $15,000 to $19,999 per year
- ○ $20,000 to $24,999 per year
- ○ $25,000 to $29,999 per year
- ○ $30,000 to $34,999 per year
- ○ $35,000 to $39,999 per year
- ○ $40,000 to $49,999 per year
- ○ $50,000 to $59,999 per year
- ○ $60,000 to $74,999 per year
- ○ $75,000 to $99,999 per year
- ○ $100,000 to $124,999 per year
- ○ $125,000 to $149,999 per year
- ○ $150,000 to $199,999 per year
- ○ $200,000 to $249,999 per year
- ○ $250,000 to $299,999 per year
- ○ $300,000 to $399,999 per year
- ○ $400,000 to $499,999 per year
- ○ $500,000 or more
- ○ Prefer not to say

Q29.
How long have you lived in your current home? [Drop-down menu]

- Less than a year
- 1 year
- 2 years
- 3 years
- 4 years
- 5 years
- 6 years
- 7 years
- 8 years
- 9 years
- 10 years
- 11-15 years
- 16-20 years
- 21-25 years
- 26-30 years
- More than 30 years
- Don’t know

Due to the size of our research study, we may take up to 21 DAYS to pay you.